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The New Home of the Western Union. THE fire of 1890 in the Western Union telegraph office in this city was perhaps a blessing in disguise, for the new quarters of that company are vastly better than the old ones ever were, both in comfort and efficiency. When one comes to realize that on two floors in a single building is located the centre of the news distributing facilities of this continent, the importance of every improvement there is a matter of public interest. To electricians the new operating rooms are particularly attractive, for there is gathered together almost every variety of telegraphic apparatus that is in commercial use, some of it very familiar and another portion hardly heard of outside telegraphic circles. Perhaps to the average layman the long distance Wheatstone transmitters are possessed of the greatest interest, but the long duplex and the quadruplex lines impress his mind, and when he fairly understands that San Francisco has literally been brought within ten minutes of New York by the system that is centred in the room in which he is standing he can comprehend something of the immense importance of the telegraphic art.

The Trolley in Brooklyn. So far as his honor, Mayor Boody, is concerned, opposition to the trolley system in Brooklyn is at an end. The ten days allowed for the consideration of the resolutions passed by the Board of Aldermen ended at noon last Saturday, and inasmuch as the mayor took no action whatever upon them they go into force at once. This is precisely what we have anticipated as a final outcome, although it is unfortunate that the mayor did not put himself on record in the matter. He seems to have been obdurate to the last, but was convinced by the determined action of the Board of Aldermen that opposition to their almost unanimous wishes would provoke ill feeling, without in any way changing the situation. The Railroad Commissioners are now disposed to look favorably on the trolley system, so that the proposed change of motive power will in all probability be made as rapidly as possible. There is little need here of discussing the general aspects of the question, but we congratulate Brooklyn on the rapid transit that is soon to be an accomplished fact, feeling confident that the vast majority of the citizens will find it a genuine blessing, in spite of the gloomy predictions of sore headed property owners, and the stubborn old fogies who seem to resist improvement as a matter of course.

Tests of Steam Turbine. IN another column we give a full report of the experiments recently conducted in England by Prof. J. E. Ewing on the efficiency of the Parsons steam turbine. We mentioned the matter recently in connection with a cable despatch, but these full tests give it even more of importance than was at first to be supposed. The only detail to be noted as not mentioned in the cable is that the turbine used was arranged for condensation. But even so the results obtained were most striking. Particularly noticeable is the high efficiency of the dynamo and engine combined at comparatively light loads, due in all probability mainly to the very low loss caused by friction in such an apparatus. Though the velocity in rotation is very high the linear rubbing velocity between the frictional surfaces is not enormously high. One somewhat important consideration is the durability of the turbine, for if the clearance between the working vanes should be increased the turbine would undoubtedly be less efficient, and it is certain that there is a tendency for steam to cut the vanes to a slight extent. How important this is in practice it is impossible for us to say in the present state of our experience, but the difficulty, if it exists, should be removable by careful mechanical work. At all events the use of steam turbines, which are likely to be tried to a considerable extent in England, should be watched with the utmost care.

The Law of Hysteresis. AT the last meeting of the American Institute of Electrical Engineers Mr. Steinmetz's elaborate paper on this subject, abstracted elsewhere in our columns, was heard with great interest. Hysteresis is the bugaboo of all who deal with alternating currents, and even now its properties are very imperfectly understood. Mr. Steinmetz's careful measurements of a large number of samples of iron of various sorts has brought together a collection of results that are of much value as data for the everyday working electrician; but it is a fact only too well known to designers of alternating current apparatus that small variations in the mechanical treatment of iron produce most erratic changes in its magnetic properties. Two or three sharp blows struck on an iron rod will alter its magnetic constants at that point in a most extraordinary manner, and a little difference in annealing produces a large and indeterminate effect on the hysteresis. As an extension of Mr. Steinmetz's admirable researches we would suggest a study of hysteresis as a function of the mechanical treatment to which a given sample of iron is subjected. Let us know not only that hardening increases the hysteresis loss in steel, but how much it increases it, and what is the best way of treating a given piece of iron to bring its hysteresis loss to a minimum. And this is not only a practical question but one that possesses a theoretical importance, for it may be possible by such an investigation to find out much about the mutual relations that exist between that extraordinary something which we call magnetization and the marvelous changes that are produced in iron by sudden variations in temperature.

Grounding the Three-Wire System. THE minds of the Fire Underwriters in and about this city seem to be perturbed just now, on discovery of the fact, well known to most New Yorkers, that the three-wire system of distribution is frequently grounded. The fact seems to have been long known, but its full significance has just dawned upon the authorities. Not that there is anything particularly mysterious about the grounding of an electric light wire, or that the three-wire system is any worse in this respect than any other grounded incandescent system. The situation is simply this: If an electric circuit of any kind be deliberately grounded a powerful current will be established in case there is connection between any metallic conductor touching the wire and any other connected with the ground. In such a condition there will soon be serious heating and possibly a dangerous arc established. It is much as if in a two-wire system the return wire were abolished to save copper, and the lamps were connected directly between the out-going lead and the earth. In its course of operation the middle wire of the three-wire system is supposed to carry little or no current, and to save copper is sometimes made smaller than any of the other leads. In case of a short circuit this difference in size tends seriously to unbalance the system. If a small middle wire is used it is frequently grounded. This may, or may not, lead to serious results. The question to be decided by the Board of Fire Underwriters is whether such grounding is in practice responsible for fires, and whether it exists to such an extent as to render restriction desirable. It may be that insurance men are more scared than hurt, for the total number of fires chargeable to electricity is really very small.

The Electrical Transmissions of Power. A VERY interesting debate before the Chicago Electric Club, reported elsewhere in our columns, again raises the old and much vexed question of direct vs. alternating currents. The question is nearly as old as the alternating dynamo, and, to express the opinion of electricians generally, those who manufacture and deal in alternating apparatus believe in its efficacy: those who make direct current machines swear by them and at the alternator. This difference of opinion will probably continue until the end of time. So far as ordinary incandescent lighting is concerned the question has answered itself very satisfactorily, and any electrical engineer who is not hopelessly bigoted is likely to use one or the other system, according to the character of the service, some even going so far as to propose to operate both from the same central station. Now, however, in the beginning of the era when current is to be transmitted miles instead of rods, new complications arise, and the merits of the case are altered by the conditions of the particular service that is to be attempted. The fundamental difference between this sort of work and lighting over the areas usually attempted lies in the fact that for economy in long distance transmission of energy it is absolutely necessary to raise the voltage far above anything to which we have as yet been accustomed. This admits of no debate, and must be taken into consideration whatever system may be employed. So long as distances of but five miles or so are attempted and a few rather large power units are to be furnished most electricians would unhesitatingly select direct current apparatus as being more familiar, of quite as high efficiency, and in every way satisfactory where the pressure is to be only one or two thousand volts. Especially is this true since the direct current motor has at present reached a far higher state of development than its alternating current counterpart. But suppose on the contrary that 25 or 30 miles are to be attempted; under these circumstances one is practically driven either to run several direct current machines in series or to fall back on the alternating current. No direct current dynamo designed to give an electromotive force of 5,000 volts or so has as yet been successfully constructed. And if a higher voltage than something of about this order of magnitude is to be used, generators in series must he employed and probably, also, motors in series. This is a material inconvenience where power is to be subdivided, and in case any considerable distribution is to be effected it becomes absolutely necessary to have a transformer station. In other words, whatever system of distribution is employed for very high voltages, such as are required for economy in long distance transmission, transformation is imperative; it will not do to take 5,000 or 6,000 volt wires into the houses of every one who desires a motor, and where the conditions are reached that compel the transmission of energy at a higher voltage than that at which it is proposed to utilize it, the alternator has an enormous advantage, not only on account of the great simplicity of the transforming apparatus but its practical efficiency. In this respect the alternate current transformer is fully 10 per cent. better than any motor dynamo, beside having the advantage of being very much easier of insulation, and far less liable to damage. Considering large units only, alternating and direct current motors and dynamos are about on a par as regards efficiency, so that if a considerable amount of power is to be transmitted and regularly employed in a few units, the drehstrom, or even the synchronous, alternating current system fulfills the conditions of efficiency and simplicity better than any combination of direct current apparatus yet devised. For example, it would have been a most difficult matter to repeat the Lauffen experiment with direct currents, inasmuch as a considerable number of machines running in series would have been requisite, any one of them much more difficult to insulate than the entire alternating system actually used, and the lights would have had to be fed through the intervention of a motor dynamo of considerable lower efficiency than the transformer. But it must be remembered that there is one very practical inconvenience in the use of alternating current distribution where many small motor units are to be operated, for we have at this time, generally speaking, no small alternating motors in commercial use that are entirely satisfactory, either in efficiency or other properties. It is unlikely that this state of things will continue, for there is promise of a remedy for this very real difficulty. Whenever the small alternating motor working on incandescent circuits appears the question of long distance transmission of power will be answered definitely in favor of the alternator. Until then there must always be a debatable ground under circumstances where a considerable number of small motors must be supplied and the distance of transmission is not so great as to call for an inconvenient multiplication of direct current dynamos and motors. At present the directions of progress seem to indicate an increasing use of alternating current motors, and a considerable hesitation among engineers in facing the difficulties of direct current transmission at very high voltages, when there is so easy and efficient an alternative.

Latest Foreign Electrical News.

(By Cable from Our Own Correspondent.)

London, Jan. 25, 1892.—The St. Pancras station inaugurated its street lighting service last week. In addition to this it has applications signed for 13,000 lights at various points of the city, already on file, so that its prospects for large business are good.

The Liverpool Overhead Electric Railway proposes not to run trains, but to follow the latest American practice of using large separate cars. For this purpose thirty 45 foot cars have already been ordered.

Electric lighting in and about London seems to continue a profitable investment, for the St. James and Pall Mall Company has just declared a dividend of 18½ per cent.

Lord Rayleigh has just been appointed Lord Lieutenant of county Essex.

Elements of Practical Electricity.*

BY DR. LOUIS BELL.

You have already seen that before undertaking delicate electrical measurements you must have a somewhat delicate instrument. Fortunately a galvanometer sufficiently sensitive and accurate for all practical purposes is easy to construct, and you can well employ your time in so doing.

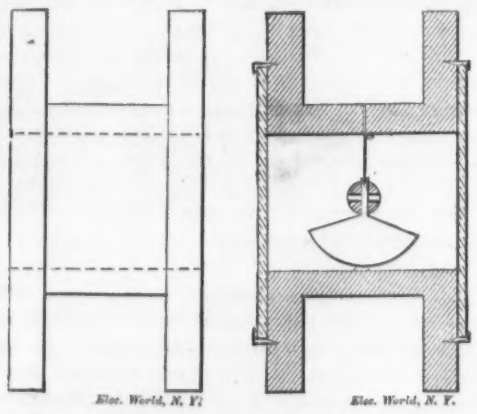
MAKING A REFLECTING GALVANOMETER.

The general principles of its construction are quite similar to those already employed for the tangent galvanometer, the difference lying in the very large number of turns of wire which surround the needle, and in the fact that the needle itself is very light and delicate, so light, in fact, that it is undesirable to use a pointer of any weight in connnection with it, and we therefore take advantage of a reflected beam of light to serve the purpose of a pointer as long as necessary and absolutely weightless. For this purpose instead of a pointer being attached to the needle it is replaced by a little round mirror, and light from a kerosene lamp, condensed into a solid beam by means of a lens, falls upon it and is thus reflected on to a graduated scale. The least deflection of the mirror shifts the position of the spot of light. As the scale is usually two or three feet from the mirror, a deflection which would be absolutely invisible with a pointer of any practical length is plainly indicated.

The first step is the construction of a circular base, which should be about seven inches in diameter and an inch and a half thick, made much like the one you used for the tangent galvanometer described long since. It should be of hard wood and provided with three leveling screws.

The next thing to be constructed is a bobbin to carry the galvanometer wire. This may be either turned out of a single piece of wood, or built up, as was the case with your tangent galvanometer ring; if turned, the wood must be exceedingly well seasoned, else the completed spool will warp. If built up, two end pieces should be glued to a turned hollow cylinder.

Fig. 32 shows the spool half the natural size. It should be four inches in diameter over all, the flanges being three-eighths of an inch thick. The body of the spool is two inches in diameter and the central aperture one and a half



Figs. 32 and 33.—Construction of Galvanometer.

inches. After completion it should be given several good coats of shellac, and it is needless to say that the workmanship should be very careful.

Before winding a very small hole should be drilled with a fine bradawl through the body of the spool directly towards its centre and exactly midway between the flanges; this should be as small as can possibly be made. Perhaps a better way than drilling is to heat a needle and burn the hole through.

You may now begin to wind the bobbin, which may be done by hand but should be done upon a lathe, as the labor of hand winding is considerable, and you are not likely to make a good job. For the coils you need a much finer wire than you have yet employed. You will require about a pound of No. 30 silk covered magnet wire. The single wound wire is all right for the purpose but must be watched to see that the insulation has not become bare. Use the white wire and not the green, as the dye seems sometimes to affect the insulating properties and has been known to produce slight magnetic disturbances. Of course if you know your wire it makes no difference, but the undyed white covering is to be preferred. Punch a fine hole through the flange of your spool on a level with the inner cylinder, pass the end of your wire through and begin winding; after each layer is on give it a very light coat of shellac, which will dry rapidly and improve the insulation When the bobbin is one-third filled, drill another little hole through the flange near the first one, pass the wire out, terminating the first coil, twist the wires together, then start in to continuing the winding and keep on until the bobbin is filled to perhaps within an eighth of an inch of the edge of the flange all around. Then bring out the end of the wire through a third hole in the flange, the second having been used for the outgoing wire of the first coil. and also for the ingoing wire of the second coil; give the hole a final good coating of shellac, and let it dry. You will observe that the two coils, inner and outer, must be wound in the same direction, just as if you had continued the winding of one. The winding is divided into the two coils

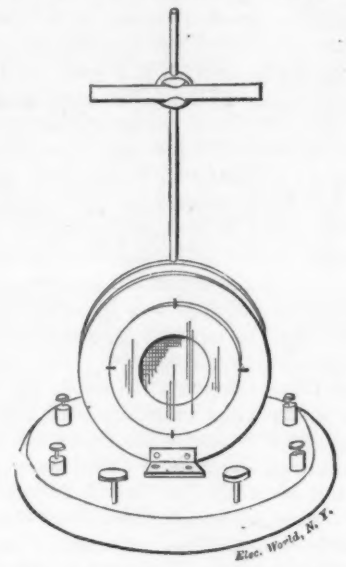


Fig. 34.—Completed Galvanometer.

so that they can be put either in series or parallel, as you may desire.

Finally, wind on the outside a couple of layers of No. 18 magnet wire and bring out their terminals, then shellac the whole and give it an outer coating of shellaced paper over the wire. The third coil is simply for convenience in doing occasional work. Fix the bobbin in the centre of its base by means of two little angle pieces of brass, fastened on with brass screws, and lead out the terminals of wire to the small brass binding posts. In Fig. 34, which shows the complete galvanometer, only four of them are shown, two of them belonging to the outside coil, of comparatively coarse wire. Add a third pair of binding posts and connect each pair to the beginning and end of one of the two coils of fine wire. You are now able to employ in your galvanometer work the outer coil of low resistance and few turns, either one of the fine wire coils, or both in parallel, giving a considerable range of action.

Now as to the needle. Procure a piece of watch spring a trifle less than three-fourths of an inch in length and magnetize it strongly, then break it in two in the middle, then procure, as can be done from an instrument maker at very small cost, a plane silvered glass mirror, which should usually be about three-eighths of an inch in diameter, fasten to its back with wax the two little magnets with their north poles pointing in the same direction, and running directly across the mirror, very close to each other and equidistant from the centre of the mirror. Do not use sealing wax, shellac, mucilage, or anything of that description, as the chances are at least ten to one that in drying it will warp the mirror hopelessly out of shape. A very small amount of wax put on the back of the magnet. gently warmed, will enable it to adhere with sufficient firmness, generally without warping the mirror. The mirror and magnets are to be swung in the centre of the bobbin, as shown in Fig. 35, which shows the magnet system in position.

Cut out of aluminium foil, if you chance to have it or can conveniently procure it, or mica, which answers almost as well, in case the foil is not at hand, a little flyer of the size and shape indicated in the cut, just half the natural size of the instrument. The tongue should then be fastened with wax across the back of the mirror perpendicular to the magnets and rising less than an eighth of an inch above the mirror. Punch a minute hole through its top for your suspension. The purpose of the little flyer is to damp the oscillations of the needle and enable it to come to rest more quickly than would otherwise be the case. Now, for the suspension, take a piece of fine copper or brass wire, No. 20 or something of the sort, and bend up the end into a very minute hook, as small as you can make it. For the suspension of the needle you want a single very fine silk fibre. This can be pulled from a silk cocoon or from fine silk floss. Work on a piece of black paper and pull out a straight and fine fibre, examining it with a magnifying glass, to see that you have not gotten a bunch instead of one. It will be visible against the black background, but not easy to see anywhere else, unless the light strikes it in just the right direction. For manipulating it you want a pair of very fine tweezers, a little soft wax, and a couple of pins; the tweezers are of little use in handling the fibre, the pins with a minute particle of wax on the point of each are much more serviceable. To begin with, pass one end of the fibre—which should be two or three inches long—through the hole you have punched in the tongue, which projects above the mirror; the end of the tongue should be clipped off until barely the hole is left above the edge of the mirror. By touching your wax upon the pin to the fibre about a fourth of an inch from its end you can pick it up and thread it as readily as you may thread a needle. Draw it through half an inch or so, and then touching the end over again with the wax, lead it around the loose end of the fibre and with the second waxed pin touch the end of the fibre on the first and pull it through the loop, thus tying a knot. You can secure it afterward if you like by a very small drop of shellac. Again taking hold of the fibre with your waxed pin, take two or three turns around your little wire hook, which should have a shank about a quarter of an inch long; the hook can be held in the tweezers, and the fibre should be a shade less than half an inch in length—seven-sixteenths, perhaps. Take three or four turns around the hook, fasten the fibre with a drop of shellac, and cut off the loose end. You now have your needle suspended from the hook; put a little of the soft wax on the shank of the hook, then take the hook in your tweezers, pass the mirror with its flyer inside the bobbin, and thrust the shank of the hook into the hole you drilled before winding, pushing it up until the centre of the needle is as exactly as you can judge in the middle of the coil. Now cut two squares or circles of thin and very clear and uniform window glass, large enough to cover the ends of the aperture in the galvanometer spool, and thus shut in the needle, and fasten them in place with little pieces of bent brass wire, as shown in the cut.

Your galvanometer is now complete, except for the directing magnet. Drill into the top of one of the flanges and insert in the hole, fitting it tightly, a piece of straight brass wire or rod about as big as No. 12 copper wire. Fit a small cork to slide upon the rod and then make out of a thin piece of steel a magnet perhaps one-fourth of an inch in width and four or five inches long, magnetize it strongly, and support it by thrusting through a slot in the cork, as shown in the cut. This serves to establish an artificial field in the vicinity of the magnetic needle, compensating the earth's field, if extreme sensitiveness of the galvanometer is necessary, or to establish a much stronger field than the earth's, in case, as often happens, you do not want great deflections. By pushing it up or down over the needle the field can be varied.

You now want a scale on which the beam of light that you are going to use for the pointer may fall. Make a stand out of inch board upon a block, as shown in Fig. 35. Its length should be about 18 inches and the height about 8: paste on the face of the board a scale of white paper graduated to millimetres if convenient, and exactly at the centre of this scale, just below, cut a slot about three-eighths of an inch wide and three-fourths of an inch long. Blacken the edges of this slot, and put upright. and centrally in it a piece of brass or copper wire, about No. 18, blackening it also. Next get from some spectacle maker a lens about an inch and a half in diameter and of about six inches focus, support this so its height can be adjusted; perhaps the easiest way is shown in the figure. Take a bottle, half fill it with sand, thrust a brass rod through the cork, put another cork on the brass rod, and hold the lens in a slit, much as you did the directing magnet of your galvanometer. A kerosene lamp completes the equipment.

In setting up the galvanometer it should be placed with the coil in the magnetic meridian, consequently with the

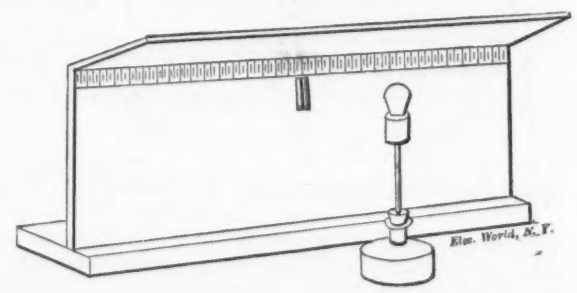


Fig. 35.—Galvanometer Scale.

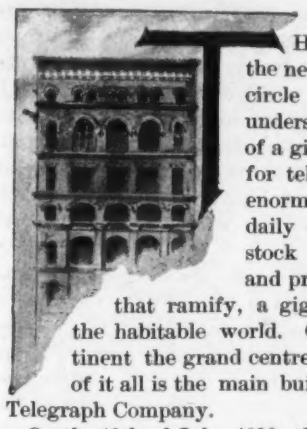
faces of the galvanometer east and west. The screens should be about 30 inches from it and placed perpendicular to the lines adjoining the centres of the two, as can readily be done by means of a T-square.

The galvanometer should be raised on blocks by means of its leveling screws until the centre of the mirror is about on a level with the lower edge of the scale. A kerosene lamp should be placed behind the slot, blocked up so that its flame is opposite the slot; place the lens directly in front of the slot, working, of course, in a darkened room, and move it forward on a direct line toward the mirror until you see that the mirror is properly illuminated, then looking on the scale you probably will find the reflected image of the slot and wire; very likely it will be indistinct, but by shifting the lens back and forward you will be able to find the point where the shadow of the wire is sharply defined on the screen. It is sometimes necessary to bend or spring the flyer below the needle, so as to shift the latter through a minute vertical angle in order to get the image properly on the screen; this, however, is generally unnecessary if care has been taken in manufacturing the needle and setting up the instrument.

(To be continued.)

* Continued from The Electrical World of Jan. 23, 1892.

The New Quarters of the Western Union Telegraph Company.



THERE are few outside of the newspaper men and the mystic circle of knights of the key who understand much about the details of a gigantic centre of distribution for telegraph dispatches, or of the enormous amount of work that is daily done in sending press and stock reports, special dispatches and private business over the wires that ramify, a gigantic spider's web, all over the habitable world. Of the business on this continent the grand centre is New York, and the heart of it all is the main building of the Western Union Telegraph Company.

On the 19th of July, 1890, the public was brought to a realizing sense of the importance of that unassuming building by a fire that wiped the operating rooms out of existence and temporarily suspended telegraphic operations in New York. The enterprise of the officials in equipping temporary accommodations soon relieved the immediate ill effects, but all through the months that have passed since then preparations have been under way to give the telegraphic art in New York suitable accommodations. Work was necessarily slow as can be realized after a glance at what has been accomplished. But everything is now nearly ready, and probably when this number of THE ELECTRICAL WORLD reaches its readers the army of operators will have been transferred to their new quarters, and work will have assumed its regular flow.

As will be remembered, the upper portion of the Western Union Building was completely wrecked by the fire, and has been entirely reconstructed. The seventh and eighth floors are given up to the general operating department; the eighth to the enormous mass of regular commercial business, while the floor below, of equal size, accommodates a wide variety of special service.

Our cut gives a view of the operating room on the eighth floor of the building. Like its mate on the story below it is 75 × 200 feet and lighted by 36 capacious windows. The ceilings are high and the room is beautifully lighted and ventilated. Standing in the main operating room at the point of view chosen by our artist one can see at a glance the centre of the main commercial telegraph system of the United States. The room is taken up by operating tables, each with its full equipment of instruments, while in the centre is a gallery where messages are received from pneumatic tubes at various points, and whence they are distributed by a very complete set of carriers. These are of the Martin system, and the motive power is obtained by endless cords all driven from an electric motor. The messages are rolled up and slipped into the carrier cylinder, which is capable of holding a dozen or so, snapped on the moving cord with a spring clip and whisked to their destination—the operator's desk at some distant part of the room. There are 75 stations at various points in the room, and the carriers are transmitted at the rate of about 750 feet a minute.

The full working corps employed in this single room aggregates a thousand, some 700 of them operators, including the night staff. Here are located the regular Morse instruments, the principal duplex and quadruplex lines, some of the printing instruments and the marine circuits to Quarantine, Sandy Hook, City Island and Fire Island, as well as the special circuits for the use of the weather signals. As fast as these are received they are distributed over the different circuits, those from the East being sent West and South, and so on for other portions of the country. They are also sent by pneumatic tube to the signal office on top of the Equitable Building. The marine circuits receive and transmit all the information regarding the incoming and outgoing vessels.

The main bulk of the work of the room, however, is the regular commercial business to all parts of the United States and Canada. About 60 quadruplex lines are here in operation, reaching all over the Eastern States and as far west as Chicago, this line, however, by means of a repeater at Buffalo. The longest quadruplex worked without a repeater is that to Bangor, Me., communicating with the cable system. Land lines are also in connection with all the European cables and to the Bermudas, Nassau, Cuba, the West Indies and South America. Some of this work is done through the central cable office at 16 Broad street, whence two of the trans-Atlantic cables are directly operated. These are also connected to the office of the New York Stock Exchange. From all the cable centres of the country there are direct wires into the Central Cable office and the Stock Exchange office. It may be mentioned here that the longest direct wire operated by the company is that from the Central Cable office to San Francisco, 3,348 miles in length, and worked duplex. It is the longest circuit in the world.

There are three main switchboards in the room, that in the foreground covering all lines East, the next the Southern lines, and the one at the extremity of the room the Western lines. These have been elaborated by the Western Electric Company and are wonderfully compact and ingenious. Above each is a bank of incandescent lamps which serve to detect grounds on the system. If the current in any line rises above a given amount through a ground at some point, the lamp corresponding to that circuit receives enough current to illuminate it, and hence makes the fault instantly visible.

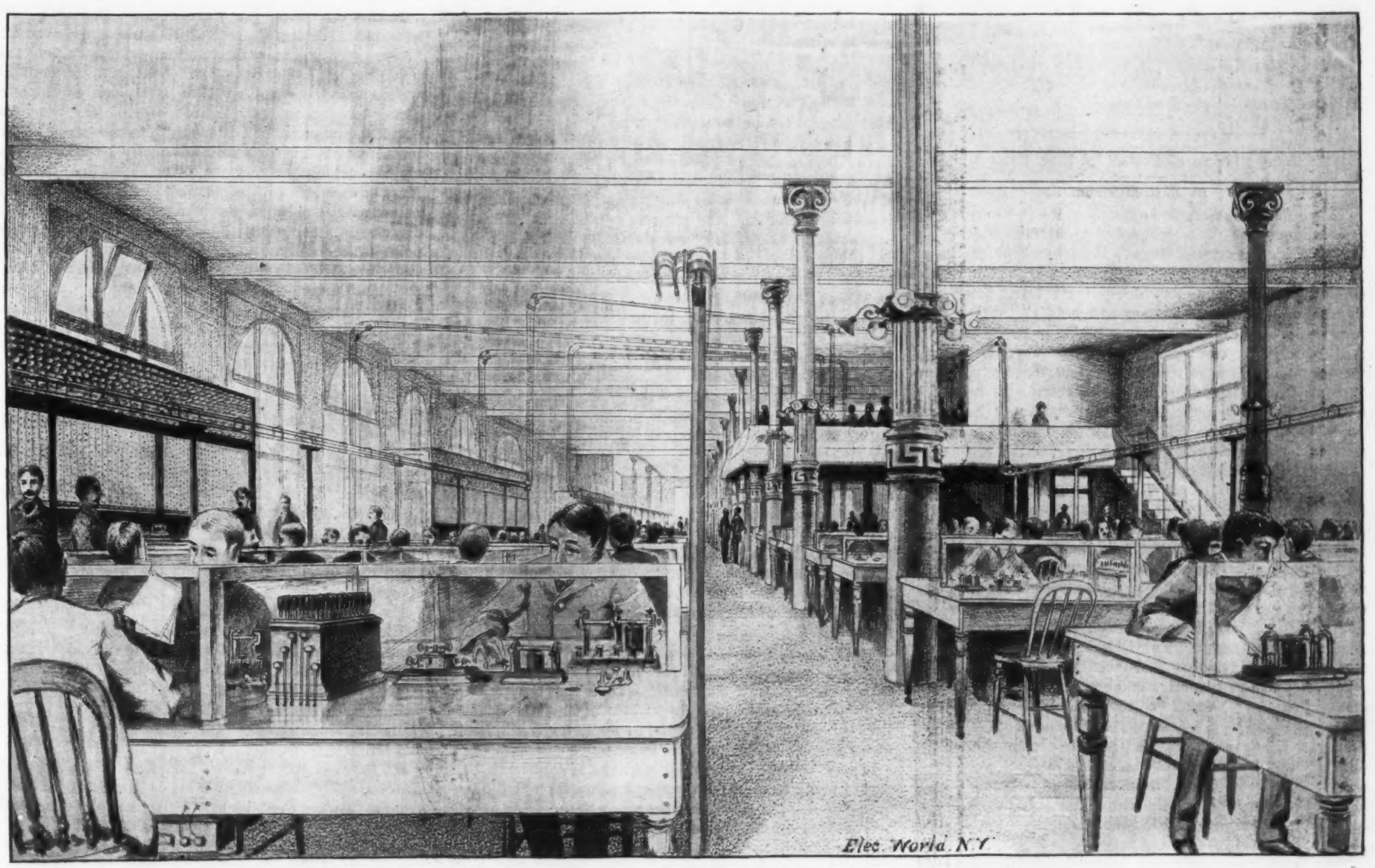
There are provisions for switching any instrument on to any line, and for any desired grouping of lines. Near the switchboard is the indicator board for the private wires running into offices of important corporations. Each wire is provided with an annunciator and drop, and in case of any trouble which requires the services of a Western Union expert the office wire is short circuited. The drop then falls, indicating that immediate attention is required. Behind one of the switchboards is the time service where the signals are received from Washington and distributed to various points in the vicinity of New York.

In the centre of the room is located the city switchboard and the special switchboard for the quadruplex lines, which are so arranged that they can be connected in any desired way to the instruments on the floor below.

No conductors are visible about the room; they disappear behind the switchboard into the cables, and pass through tubes to the basement of the building, thence through underground conduits, only to reappear at the outskirts of the city. The distributing wires to the instruments are carried under the tiled floor, and are throughout packed in fine dry sand, so that even if a cross circuit occurred any fire would be smothered long before it could get under way. Traps under the tables enable the cables to be reached. As is well known, the entire service is carried on by dynamos. There is not a primary battery in the building.

Interesting as this main operating floor is, more striking still is the one beneath, for on it is carried on a vast variety of service. At the east end of the floor is the superintendent's office, and at the opposite end the bookkeeping department, while between them the space is taken up with the commercial service of the company. This collects and distributes the entire quotation service of the country. Here are all the tickers of the Gold and Stock Company, and also the ticker service for the grain, oil, coffee, financial and general news work, besides Morse wires, mostly duplex and quadruplex, connecting them with all the exchanges and all the principal cities of the country. The variety of instruments is something marvelous. Most interesting, perhaps, is the Wheatstone transmitter service. There are four long lines worked by these automatic transmitters, two to Chicago, one to St. Louis and one to New Orleans. As most of our readers will remember, the Wheatstone transmitter is operated by means of perforated characters cut through a paper tape by means of a sort of modified typewriter. These tapes are then run at high speed through the transmitting instrument, which is so arranged that the regular Morse signals are sent at an enormous rate upon the line and received on tape at the other end of the line. The regular speed of working is about 150 words a minute for the single wire, and when the department is in full blast some 30 punchers are required to prepare the messages for transmission in order to keep up with the speed of the instruments; as many typewriters are required to copy the messages from the receiving instruments.

In the room, too, are the repeating instruments, and the instruments for the special wires leading to brokers, newspaper offices and other important concerns. As may be imagined, to keep all this apparatus in order is no small task, and a considerable corps of experts is kept busy seeing that everything is in proper working trim. On this



GENERAL VIEW OF THE INTERIOR OF THE NEW WESTERN UNION OPERATING ROOM.

floor are the assorters, inspectors and service clerks, keeping the messages arranged in order of the place of destination, seeing that every message takes its proper marks and finally turning the blank over to be filed in the book-keeping department.

The messages are received from the floor above, where, as already mentioned, the pneumatic tubes centre in the distributing gallery. These connect through the receiving and delivery departments on the basement floor with the various offices and floors in the building, with the down-town exchanges, newspaper offices and various uptown quarters of the company. Direct tubes to the newspaper offices are worked, however, from the basement floor.

The wires distributed over the entire operating department pass downward to the cellar, and are connected there with a gigantic testing board, which will accommodate, 3,500 wires and these pass through 36 cables into the various underground conduits provided for their reception.

The distributing cables in the building are, as have been mentioned, carried under the floor in trenches filled with sand, and aggregate someting like 200 miles in length. About a mile of duct is necessary in conveying these cables to various parts of the building. In the cellar, too, is the dynamo plant, including now 41 machines, part of them being kept as spare. These furnish all the current, even that for the local circuits, and for regulating the current for various purposes. Something like 3,000 incandescent lamps are required. The total number of employés of the operating department rises to over 1,200, and the service is still growing. The new operating rooms are specially well adapted to facilitate the transaction of the enormous business that has to be handled in them, and really the fire was not an unmixed misfortune, for the improvements that have been made are great and many.

Transmission of Power by Electricity.*

BY D. C. JACKSON.

The subject for discussion announced for this evening by your committee is the advantage of multiphase alternating currents in power transmission. On account of the magnitude of the subject I will confine myself to plants of a single type, *i. e.*, plants in which power is transmitted and distributed for general commercial operations. The source may be distant or central. An example is to be seen in any commercial power plant where the power is sold to various manufacturers and the motors have a capacity varying from 5 h. p. upward. Another example is that of a mining plant where the power is utilized for various purposes, as driving the mill, ventilating, drilling, hoisting, pumping, etc., and motors of various capacities are again required, each operating under its own peculiar conditions. It is evident that the plant must be capable of extreme flexibility in distribution, and the electric pressure at the motor must be within the limit of danger to a careful attendant. Commercial plants of this type are increasing in number and importance, and experience shows that the increase would be even more marked were it not for the difficulties and expenses entailed on long distance transmissions by the use of continuous currents. In the near future general engineering practice will look to this type of plant for its precedents in power transmission, and sound financial and economical construction will obtain. There are many plants that are so small or from which the product per horse power is so great that efficient operation is unimportant. These plants can be installed with the prime object of fulfilling their duty regardless of cost, yet, paradoxical as it may seem, the plants may be economical. Paradoxes must be left to the individual skill of the constructors, while we discuss the economical *commercial* plant.

That direct transmission of power by continuous currents in this type of plant must be limited in pressure and therefore in what may be called transmission radius will be admitted by all. Beyond this limiting radius the economy in using continuous electric currents is doubtful, as resort must be had (1) to dynamos and motors respectively generating and utilizing excessive pressure, or (2) to motor generators used as converters. In either case the result is shown by experience to be unsatisfactory if not disastrous. Under ordinary conditions the maximum pressure that can be used satisfactorily with a Siemens armature is shown by practice to be 1,250 volts in power transmission dynamos. A Gramme armature with its advantages in mechanical arrangement and insulation of the wires may possibly give satisfaction at 2,500 volts for power transmission, but the generation of large currents at 2,500 volts pressure by continuous current dynamos is not likely to become general. Two high pressure generators can be safely worked in direct series or on the three-wire plan, as has been done in Switzerland and this country. By this means a considerable "transmission radius" is secured, but the motors must be in large units, and also worked in series, or a step down converter station is required. This arrangement is, therefore, inflexible, and does not come within our scope.

By an examination of current practice, and of the results attained in existing electric plants, we are driven to the conclusion that 1,000 volts at the motors is the maximum safe pressure to be used in commercial power distribution. Where motors as small as five h. p. are used, even this pressure should be divided by the three-wire arrangement or some other satisfactory method. The economical limiting distance for 1,000 volts at the motors is shown by practical experience to be about four miles. Under special conditions, particularly in small plants, this limit may be considerably exceeded, but only where the conditions will permit an excessive cost, either in installation or operation.

With these considerations, which I do not think will be seriously disputed, we arrive at the following conclusions: First, A commercial transmission plant which covers a radius of four miles or less can be economically and safely operated by continuous currents, with the pressure at the motors not exceeding 1,000 volts. Second, for transmission radii greater than four miles we are forced to the use of excessive and unsafe pressures, or to the use of transformed pressures. We will discard the former as being uncommercial, and therefore poor engineering. It is well known that either continuous or alternating currents can be transformed, but with continuous currents, revolving motor generators, or step down stations of motors and dynamos are required, thus demanding impracticable expenditures for installation and maintenance. In addition the disadvantage of high pressure dynamos at the generating station must be faced. On the other hand, in the case of alternating currents, the conditions of transmission are favorable. At the generating station the dynamos can generate a low pressure of 100 to 500 volts, and by converters the pressure can be economically raised such an amount as is required for efficient transmission. At the distributing end of the plant the pressure can be readily and safely reduced any extent required for motors, lighting, or other purposes. Here, however, is faced the problem of an alternating current motor. Its difficult solution has been industriously sought, and is now apparently discovered in the multiphaser.

Where converter stations are demanded by the conditions, there seems no possible reason for assuming much difference in the *mechanical* efficiency of power transmission by continuous or by alternating currents when the lines are similar and the pressures equal. The efficiency attainable by alternating currents was illustrated at Frankfort, where a commercial efficiency of about 60 per cent. was obtained with a "transmission radius" of 110 miles. Doubtless the national love for a scientific novelty has led the Germans to over-estimate the originality and importance of the experiments with multiphase currents shown at Frankfort. It must be admitted, however, that the self-starting three-phase motors exhibited at the Frankfort Exhibition evidence a distinct advance in the use of electric currents to transmit power. The use of single-phase alternating currents on the commercial transmission plant is admitted to be impracticable. The conditions demand an efficient motor which is self-starting under load, controllable at start, of dimensions and weight comparable with continuous current motors, of comparatively slow speed, and the cost of which is not excessive. The three-phase motors exhibited at Frankfort showed all of these characteristics in a marked degree, according to the reports of their service. We are, therefore, assured that the multiphase alternating current motor is a practical success. Before such a motor can be entirely satisfactory in this country the rate of alternations now used in commercial work will doubtless be reduced, at least for use on power transmission plants. It is even probable that the high rate of alternations used by the American companies has been an important cause of our failure to apply the multiphaser, when first developed by Tesla, to extended practical work.

It may be well to consider here the organization of a plant for the commercial electric transmission and distribution of power. Assuming the site and buildings for the generating station to be secured, the main divisions of the plant are:

1st. A properly proportioned prime power plant, ordinarily actuated by water in long distance transmissions.

2d. An economically arranged battery of electric generators, with proper regulating devices, capable of generating a pressure which is safe and easily handled.

3d. A substantial transmission and distribution line so designed and built that it neither costs excessively in construction nor requires an excessive outlay for operation due to maintenance and power losses.

4th. Motors which can operate efficiently and reliably under the pressure at which current is furnished to them.

Examining the second and fourth requirements and the third, we find diametrically opposed conditions for long distance transmissions. To build a long line at a fair first cost without entailing an excessive "drop" demands a high pressure. But we have seen that the dynamos must be of moderate pressure in order to be safe and economical, while the pressure at the motors should not exceed 1,000 volts. Therefore to fulfill the second, third and fourth requirements at the same time the "transmission radius" must be limited to four miles, unless a compromise can be effected. With alternating currents the compromise is effected by the converter and all the requirements are fulfilled at once. The direct current transformer we have found impracticable, and unless some of the requirements are sacrificed with a resultant loss of economy and reliability, continuous currents cannot be used. We thus see that for "transmission radii" greater than four miles alternating currents have evident advantages which make them pre-eminent. As the motor which has been developed is a two or three phaser, the line must be erected upon the three-wire plan. That this is not a material disadvantage is proved by the satisfactory service of numerous three-wire short distance transmissions using continuous currents. The multiphase alternating current has some incidental advantages, several of which will doubtless suggest themselves to you. It seems reasonable to expect the operation of solenoid drills and similar machinery directly from the circuits. Incandescent lamps can be operated from the circuits as in the usual alternating system. Each large motor can be operated from an individual converter at a pressure of 500 volts, while smaller motors and lamps can be operated at a pressure of 110 volts or less.

We are now in a position to modify our conclusions as may be required, and make them definite, thus:

1st. When the "transmission radius" exceeds four miles, with a satisfactory motor, which is apparently now at hand, multiphase currents (either two or three-phase) have evident superiority over continuous currents for plants intended to transmit and distribute power for general commercial purposes.

2d. When the "transmission radius" does not exceed four miles continuous current distribution, without transformers, using a pressure not exceeding 1,000 volts at the motors, has the advantage of simplicity and efficiency.

3d. The advantages to be derived from the operation of incandescent lamps in parallel, solenoid machinery, etc., upon the motor circuits may in some cases confer superiority upon the multiphase currents even within the four-mile limit.

In this discussion you will doubtless find little that is new, but if the arrangement of what is already known leads you to appreciate more fully the importance of the multiphase current I shall be well satisfied. Many inventors and writers who have dealt with the advantages of the multiphaser have made liberal use of mathematics. Some have developed theorems of evident truth as the result of their mathematical investigations, but many have derived conclusions evidently erroneous. The subject (like the "minimum economical cost of plant") is one in which correct mathematical premises are elusive, and the best doctors disagree in their analytical deductions. From the standpoint of the practical electrician, the conclusions derived above are evidently reasonable, and they are upheld by experience. I see no reason to believe that multiphase currents will seriously invade the fields now occupied satisfactorily by continuous and single phase currents, but it seems evident that the multiphaser has a field peculiarly its own in a certain type of power transmission plants.

* A paper read before the Chicago Electric Club, Jan. 18, 1892.

American Association of Inventors' Annual Meeting.

On Jan. 19 the second annual meeting of the American Association of Inventors and Manufacturers was held in the Reading Rooms of the *Inventive Age*, in Washington. This important organization is the outgrowth of the patent centennial celebration which took place in Washington last April, and its membership comprises some of the most distinguished inventors, scientists and manufacturers in the country.

The officers for the first year were: President, Dr. R. J. Gatling, Hartford, Conn.: first vice-president, Gardiner G. Hubbard, Washington, D. C.: second vice president, Thomas Shaw, Philadelphia, Pa.; third vice-president, Prof. W. A. Anthony, Manchester, Conn.; fourth vice-president, Benjamin Butterworth, Cincinnati, O.; secretary, J. Elfreth Watkins, Washington, D. C.; treasurer, Marvin C. Stone, Washington, D. C.

Dr. Gatling, the venerable president of the association, presided. Treasurer Stone made a statement of his accounts, showing that the association has no debts and a balance in the treasury. Commissioner of Patents Simonds made a telling speech in which he heartily indorsed the objects of the association and said that its aims had merits which augured a bright future of usefulness. The Association, he thought, had great possibilities and could accomplish important results. It could aid very materially in securing just and adequate protection of the rights of American inventors. It could stimulate the growth of intellectual progress and help to throw needed safeguards around its membership. Addresses were also made by Col. Thomas Shaw, of Philadelphia; A. F. Andrews, of Connecticut; Oberlin Smith, of New Jersey; Howard T. Simons, of Ohio; W. C. Dodge, of the District of Columbia; John V. Rice, Jr., of New Jersey, and others.

The organization then proceeded to elect officers for the year 1892. Dr. R. J. Gatling, the well known inventor of the Gatling gun, was re-elected president by acclamation, and Mr. George C. Maynard, the well known electrician, was unanimously elected secretary and treasurer. Mr. John V. Rice, Jr., was elected delegate from New Jersey. All of the old committees were unanimously re-elected as follows:

Executive: Gardiner G. Hubbard, chairman; David G Weems, Marvin C. Stone, R. J. Gatling, J. Elfreth Watkins.

Advisory to the Council: Hon. W. E. Simonds, Hartford, Conn.; W. J. Johnston, The Electrical World, New York City; James T. DuBois, *Inventive Age*, Washington, D. C.; J. H. Gridley, *Scientific American*, Washington, D. C.; William Butterworth, Washington, D. C.

A resolution was passed authorizing the delegates from the different States to receive contributions from manufacturers and members for the association funds, and the meeting adjourned to meet in Washington, Jan. 19, 1893.

The Uses of Electricity in a Modern Residence.

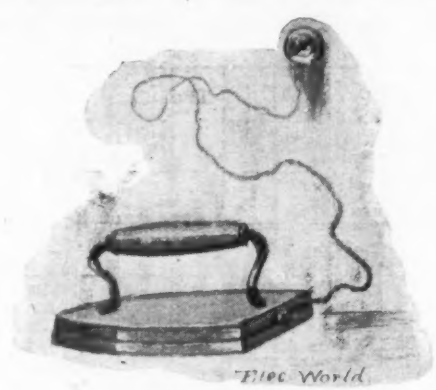
BY H. WARD LEONARD.

SOME time ago it was the popular impression that the electric light was not suited for use in residences. No greater mistake could have been made, as all know who are now using incandescent lamps in their homes.

There are several causes for this mistaken idea. First, "electric light" to the majority of people even now means an unbearable glare, an unsightly piece of apparatus, a hissing noise, an occasional blinding flicker, and a possibly instantaneous death. In other words, the arc electric light of only a few years ago made a vivid impression on their minds which has not yet made it possible for them to appreciate that the electric light in the shape of the incandescent lamp is to-day the softest, most artistic, safest, cleanest, healthiest, most convenient and most economical light that can possibly be placed in their homes.

This popular prejudice against electric light has made its introduction in residences comparatively rare. Also the fact that the residence section is usually most distant from the central station, and that the possible revenue to the electric illuminating company is not so great as from a business section, both of which reasons have made the illuminating company slower in extending its mains into the residence section.

During the past year there has been a most remarkable extension of the system of conductors of the illuminating



A TYPICAL APPLICATION OF ELECTRIC HEATING.

companies into residence sections, owing to their previous successful occupation of the business districts.

Only a very small percentage of those who can now be served with the greatest luxury of the age appreciate the fact, and it is to the remaining great majority that this brief description is addressed.

The uses of electricity in a residence may be treated under the following heads:

1. Electric lighting.
2. Electric power.
3. Electric heating.
4. Electric bells, annunciators, etc.

The incandescent lamp is without dangerous heat, is free from odor, absolutely clean, and is controllable at the lamp or from a distant point, if desired. Hence, the lamps may be placed anywhere desired, and we are not limited, as with gas, to a rigid fixture placed in the midst of a large space, and with the lights all necessarily pointed upward.

The lamps can readily be placed upon the ceiling or walls, or in recesses made in them for the purpose. The

A PORTABLE FIRE ENGINE FOR A COUNTRY RESIDENCE.

fixtures can be made of any conceivable design, and lamps of any candle power and color be placed in any position upon them.

In lighting a residence, we should dismiss from our minds all preconceived notions based upon the use of gas and oil.

Where do we want light? How much? Of what character? and where controlled from? Make such a specification and give it to a concern experienced in such electrical construction work, and the desired result will be obtained in every case.

If we have outside lights they will be unaffected by the weather, and controlled from just inside the door. Lights in a stable will be controlled either from the house or stable at will. Lights in a cellar or dark basement will be controlled by a switch placed at the entrance, so that the lamps will be lighted before we enter, and extinguished when we have left.

Every bedroom, closet, storeroom, etc., will be lighted by a lamp which lights up automatically as we open the door, and is extinguished when the door is closed. The convenience of this device can only be appreciated by those who have had experience with it. In many places in the house we will have a lamp which can be operated either at full candle power or at a very much reduced candle power at will.

In the parlors we will have all the beautiful effects produced by piano lamps, banquet lamps and fairy lamps, without any of the present accompanying care, danger, heat and disagreeable odor.

Every room will have a switch placed beside the doorway, so that the lamps can be most conveniently controlled by a person entering or leaving the room.

In such a house the most timid child, of but a few years, will go anywhere with safety and without fear, lighting and extinguishing the lamps as desired.

The lamp bulbs will be clear, frosted, colored or opalescent, as occasion requires. We will have, in every place desired, the softest, steadiest and coolest light obtainable.

The most beautiful effects can be obtained in the dining-room and upon the dinner table. Electric candelabra can, if desired, be used, which will be identical in appearance with those using candles.

Pictures can be lighted in a manner entirely impossible with gas.

The most delicate and beautiful colors in paintings and decorations retain indefinitely their original beauty, since the bleaching and blackening effects of gas are entirely absent.

It is probably but little appreciated, but entirely true, that the greatest expense due to the use of gas in a handsome residence is the depreciation it effects upon the costly materials in the residence, rather than the bill for the gas itself.

A few years ago there was a probability that the wiring of a residence would in the future fail or prove unsuited to

THE ELECTRIC LIGHT IN THE PARLOR.

the system of lighting which it would be desired to use. This condition of affairs does not now exist. The commercial systems of electric lighting have become as fixed, as regards the interior wiring, as have the gas systems; and to-day it is possible to wire a building for electric lamps with a much greater certainty that the result will be permanent, satisfactory and suited to future use than is possible in the case of gas piping.

If the building is not to be lighted for some time, it should be equipped with a system of interior electric conduits which make it possible to draw in any wires desired at any time in the future, or to replace wires previously drawn in.

The first cost of wiring varies widely. An average figure will be about two dollars and a half a lamp; but in some instances it will be as low as one dollar and a half per lamp, and in others as high as four dollars per lamp. It will rarely exceed these figures when a residence is wired throughout.

The charge for current is, for the same result, about the same as gas. The current used can be accurately recorded by an electric meter; hence the bill will be exactly proportional to the consumption of current.

The most conspicuous and important application of electricity for power purposes in a residence is for operating an elevator. It is possible to-day to have in a residence an electric elevator, which is reliable, simple, safe, convenient and economical to operate.

There is no engine, pump, tanks, pipes, valves, and the multiplicity of devices which are required for the steam or hydraulic evevator.

There is no noise, heat nor smell accompanying its use, and it is always ready to operate, and can be operated with perfect safety by a child.

There is no hand rope, the control being effected by the movement of a small electric switch in the elevator car itself.

The motion of the elevator is perfectly smooth, and it can be made to go at any speed in either direction. It is automatically stopped at the top and bottom floors, and no accident can occur, even though the electric supply should fail entirely.

An elevator boy is unnecessary, as the elevator can be controlled from any floor and brought to the desired floor, when the elevator door can be opened, but not until then. While the elevator door is open it is impossible to operate the elevator from any of the floors, so that there is no danger of any movement of the elevator while a person is getting in or out of it.

The first cost of such an elevator will be from $2,000 to $3,000. The expense for the current for operating it will,

A PROPOSED USE OF THE ELECTRIC MOTOR.

in ordinary instances, not exceed $5 per month, and the cost of maintenance will be but a few dollars per year, as it is entirely simple, and requires almost no attention.

No greater luxury than a passenger elevator can be placed in a residence; and it has been only very recently that such a luxury could be provided; for in case of a hydraulic elevator, the water for which was pumped to a tank above by means of a steam engine, gas engine or electric motor, the complication and expense of attention and maintenance was practically prohibitory, and the unreliability very annoying.

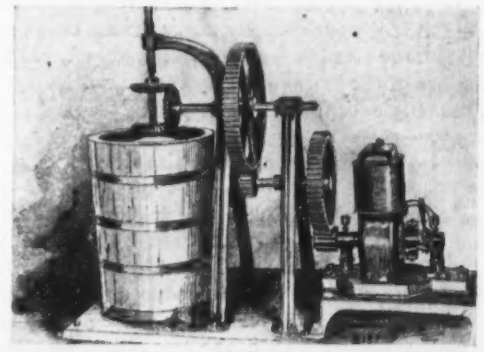
Many complex methods of operating directly by an electric motor have hitherto been attempted, and many are still upon the market; but in order that an elevator shall be worth having in a residence, it must be entirely free from complex apparatus and must be always reliable, simple and smooth in its operation, and it has been only very recently that a direct method of operation has been developed which is free from the complication of rheostats, brakes, solenoids, etc., which have characterized the electric elevators heretofore, and rendered them uncommercial except in expert hands.

Other applications of power in a residence are the operation of dumb waiters, small ventilating fans, ice cream freezers, the pumping of water, etc.

The dumb waiter will need a motor of perhaps ¼ h. p., costing, with its gearing, perhaps $150. A small electric ventilating fan will cost about $25 complete. An ice cream freezer will require a quarter or half horse power motor, and will cost complete from $100 to $200. An automatic electric pump will cost about $200.

The expense of operating all of these convenient devices will probably not exceed $50 per year, even when used a great deal.

Heating by electricity is, generally speaking, the most extravagant luxury obtainable from its use. Hence, the



SMALL ICE CREAM FREEZER DRIVEN BY A MOTOR.

heating of large spaces continually would be out of the question, except where power has but little value.

But when we wish a perfectly controlled, safe, instantaneous heat for occasional use, we can obtain it readily, conveniently and economically by the electric current.

For instance, electric flat irons can be operated in a most satisfactory manner by making connection in any incandescent lamp socket. The flat iron, in a few seconds, reaches a sufficient, but not scorching, heat, and remains at this heat continuously. The cost of the flat iron is but a few dollars, and the cost of operating about five cents per hour.

Various cooking operations, such as boiling eggs, making coffee, cooking batter cakes, etc., can be performed in a

most perfect and convenient manner, and the development of the uses of electric heating for cooking operations will be very rapid in the immediate future.

With the introduction of the incandescent light into a residence the nuisance of inoperative electric bells ceases. Having a constant source of electric supply we are no longer at the mercy of the battery which has "run down"; nor will we need the high-priced services of the so-called electrician, who has been with us so much in the past.

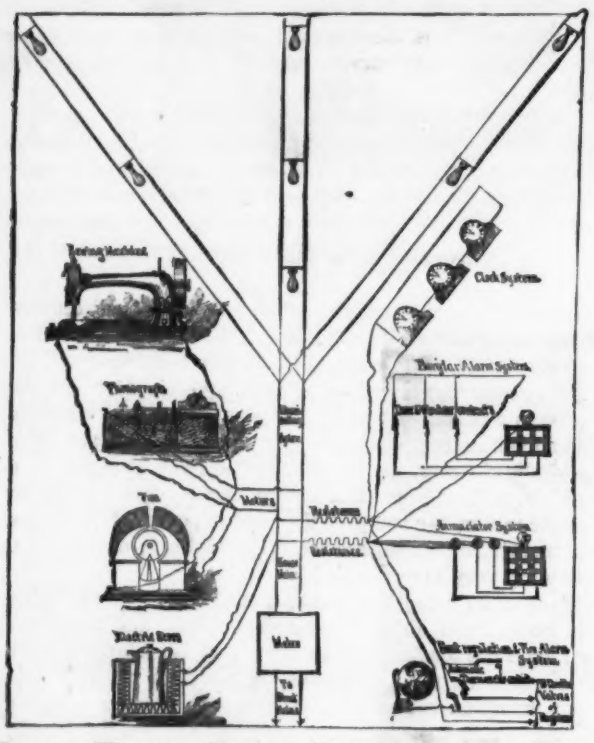
In a residence having incandescent lamps, our electric bells, annunciators, etc., will be always perfectly reliable, and will require no attention whatever for an indefinite period.

A few residences in this country are supplied with individual electric plants. But, aside from the first cost, the care and expense of maintenance has made such instances very rare.

It is now possible to utilize a windmill for an isolated residence plant, so that in an extremely simple manner the windmill will produce electricity for lighting, operating an elevator, chopping feed, sawing wood, etc., etc.

A small storage battery is used to provide means for keeping up the service when there is no wind.

The great difficulty has heretofore been to govern the



Plan of Wiring a Private Residence for the Various Applications of Electricity.

(This cut is from "Electricity in Daily Life;" copyrighted by Chas. Scribner's Sons.)

windmill, and many unsuccessful attempts have been made in this line.

The present and successful method, however, makes no attempt to govern the windmill; but in a very simple manner provides means so that, whether the windmill goes fast or slow, the dynamo for the incandescent lamps is operated at a constant speed; and, hence, maintains the lamps at a constant candle power.

The cost of equipping a country residence with such an electric plant complete, with wiring, windmill, dynamo, storage batteries, etc., is about $1,500, and the expense of operating will be almost negligible. Where several residences are lighted from one such plant, the cost per residence can be made much lower than the figure given.

The safety, convenience and adaptability to use for any lighting or power will make such plants very numerous in the immediate future, especially along the sea coast, where the wind is more reliable than inland, and where, therefore, the size of the storage battery can be extremely small and its use only exceptional.

An Electrical Mail Carrier.

A plan to carry the mails by electricity between New York and Brooklyn has been submitted by Mr. A. Bryson, Jr., of New York, to Postmaster Collins, of Brooklyn. It is the result of an act recently introduced in Congress by Mr. J. J. Clancy, which provides for the better transmission of mail matter between the two cities, by means of pneumatic tubes, electrical or other appliances, and authorizes the appropriation of $95,000 for the purpose. A similar bill has also been introduced for experimenting between New York and other cities. Mr. Bryson's system consists of a traveler, say 6 feet long and about 11 by 16 inches in breadth and height, to the back of which is attached an electric motor about 8 inches square; this is acted upon by an electric wire which runs along the bottom of an iron or steel cube, which incloses the whole arrangement. In fact it is the trolley system on a reduced scale, and the live wire which supplies the power is fed from one end or the other of the route. The rapidity with which the traveler is propelled may vary, depending on the amount of energy called for. From 70 to 100 miles an hour, or even higher speed, can be obtained. All the advantages which the pneumatic system could give would be obtained, but with much less expense for the plant and its maintenance.

The Parsons Steam Turbine Dynamo.

The following report, by Prof. J. A. Ewing, of some trials of a 100-unit Parsons steam turbine dynamo at Heaton Works, Newcastle-on-Tyne, was submitted at an inquiry held by the Local Government Board, on Dec. 30, 1891, with regard to proposals of the corporation of Cambridge to adopt a scheme of electric lighting:

The machine tested is, I am informed, the first condensing steam turbine that Mr. Parsons has built. Its shaft was designed to carry six small and one large plate or disc, each fitted with a series of rings of turbine blades, the large plate being specially designed to deal with low-pressure steam. After passing it, the steam was exhausted into a jet condenser of novel design, the pump of which was driven by a separate donkey engine. The turbine rings were of the outward flow type.

The turbine was designed to work with steam at an initial pressure of 140 pounds per square inch, but on the occasion of the trials it was not practicable, for want of a suitable boiler, to use a pressure of more than 95 pounds per square inch. The first and second plates, with their turbine blades, were accordingly removed, and the tests were made with the remaining four small and one large plate. The effect of this was to make the results of the trials less favorable, as to economy in steam consumption, than they would have been had the full initial pressure of 140 pounds been available.

In line with the turbine shaft, and directly coupled to it, was the armature of an alternate current dynamo capable of yielding 100 kilowatts, or 100 Board of Trade units of electrical energy per hour, and wound for a potential of 2,000 volts. The exciter was a distinct small dynamo of the continuous current Gramme type, which was also mounted on a prolongation of the turbine shaft.

The turbine ran at a speed of about 4,800 revolutions per minute, and the armature was wound with a single coil, so that the frequency of the alternations was about 80 complete periods per second.

The whole machine, comprising the turbine, dynamo and exciter, weighed about four tons; its length was about 14 feet, and its greatest breadth barely three feet. It stood on three cast-iron pedestals resting on an ordinary concrete floor. There were no holding-down bolts or special foundations, and none seemed to be required. The machine ran almost without vibration.

In the trials the current generated was spent on a bank of resistance coils consisting of open spirals of iron wire strung on wooden frames. The output was varied, in successive trials, from about 20 units per hour, or, say, one-fifth load, to 100 units per hour, or full load. The loads spoken of are the amounts of electrical power spent in the external circuit, and do not include the work done by the exciter in supplying current to the field-magnets of the main dynamo. (The output of the exciter was about two and a half units per hour.)

In two additional trials there was no external load beyond what was necessary for measuring the potential.

The experiments were arranged to give complete information of the amount of steam used by the turbine under all grades of output, from full load to zero.

The electrical output was taken to be the product of the effective volts at the dynamo terminals into the effective ampères. The volts were measured by aid of a 2-h. p. transformer, which transformed down in the ratio of 1 to 10, and a pair of Cardew voltmeters. To test the accuracy of the professed ratio of transformation, the volts were on one occasion read by applying a Cardew voltmeter to successive portions of the bank of resistance coils (then grouped in series) so that the potential was directly determined by summing up the readings. This determination was found to agree exactly with that obtained by means of the transformer.

The Cardew voltmeters were themselves tested by comparison with a third Cardew, which in its turn had been standardized by help of one of Sir William Thomson's balances. They were found to be correct.

The current was measured by (1) an Evershed gravity ampère meter, and (2) a Siemens electro-dynamometer. These were connected in series in several of the trials, and were found to be in perfect agreement. The Evershed instrument had been tested against a Thomson balance.

The consumption of steam in the turbine was measured by passing the feed water through a measuring tank, the capacity of which I checked. Steam was supplied from an old boiler of the locomotive type, at a pressnre of 90 pounds to 95 pounds per square inch. The steam pipe was too small, and the loss of pressure between the boiler and the turbine must have been considerable, especially in the full power trials.

In the full power trials this boiler was insufficient to supply all the steam, and another boiler was joined to it. It was then impracticable to measure the feed, and the amount of steam passing through the turbine was estimated in these trials by measuring the rise in temperature of the water discharged from the condenser, in conjuction with the amount of the water, as gauged by means of a weir. This rise in temperature and the head over the weir were noted in all the trials, so that when the feed was directly measured a constant was determined which could be applied in cases where a direct measurement of the feed was impracticable.

The boiler was old and leaky, but the amount of water which fell to be deducted from the whole feed on this account was repeatedly determined. The allowances made for leakage are certainly not excessive, and do not in any case affect the full power trials materially.

The steam required for (1) the feed pump and (2) the air pump was supplied by a separate boiler, and is not included in the quantities that are stated below.

The vacuum ranged from 28½ inches at light loads, to 26½ inches at full load. The temperature of the cold well varied from 5 degrees C. to 18 degrees C.

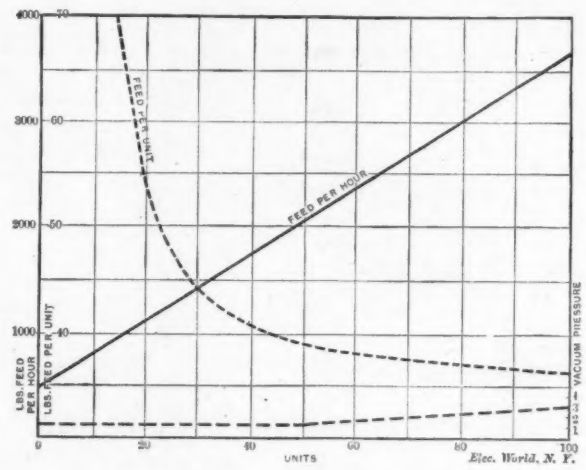
The trials extended over three days—Dec. 12, 14, and 15, 1891. The turbine was kept running, without change of load, long enough in each case to secure a uniform régime, and to prevent any material error from being caused by an inexact reading of the water-gauge glass on the boiler. The machine ran without any hitch throughout all the trials.

The following are the observed results. The trials distinguished by an asterisk are those in which the consumption of steam was inferred from the rise of temperature in the injection water. In the other trials it was measured directly, as feed-water.

Electrical output in units generated per hour.	Steam used in the turbine in pounds per hour.	Electrical output in units generated per hour.	Steam used in the turbine in pounds per hour.
0.3	510 } 492	65.9	2,460*
0.3	475 } (mean)	66.5	2,580
20.8	1,120	93	3,530*
31.2	1,350	100	3,600*
48.5	1,875		

These results are also shown graphically in the accompanying curve, which shows the relation of the number of pounds of steam used by the turbine per hour to the number of electrical units generated per hour.

It is convenient also to express the results in another



Trial of the Parsons Steam Turbine.

way, by stating the number of pounds of steam used per unit generated, at various rates of output from full load downward. These quantities, obtained by measurement from the curve, are given in the following table:

Output in units per hour.	Number of pounds of steam used per unit.	Output in units per hour.	Number of pounds of steam used per unit.
10	77⅙	60	38
20	53	70	37½
30	45	80	37
40	41	90	37
50	39	100	37

It will be seen from these figures that the consumption of steam by this condensing turbine was 37 pounds per electrical unit generated, when the machine was giving its greatest output; that the output might be reduced to, say, three-fourths of its greatest value without causing any sensible addition in the consumption of steam per unit; and that at half load the consumption was 39 pounds per unit. When the load is further reduced the consumption per unit increases, as it does in all engines, on account of the work which is expended within the machine itself.

The consumption of 37 pounds per unit at full load corresponds to 27.6 pounds per electrical horse power per hour; and the consumption of 39 pounds per unit, at half load, corresponds to 29 pounds per electrical horse power per hour.

For the sake of comparison it may be added that in a good ordinary compound condensing engine of corresponding power, the consumption of steam is usually about 20 pounds per *indicated* horse power per hour, which corresponds (allowing for necessary loss in transmission to the dynamo) to, say, 36 pounds per unit. In the special type of single acting high speed engines made by Mr. Willans, and successfully used in many electric light stations, the consumption of steam at full load and at moderately full load is somewhat less. The best results in trials published by him show (with high pressure and triple expansion) a consumption equivalent to about 30½ pounds per unit in a non-condensing engine, and 25 pounds per unit in a condensing engine, worked at full load; while at half load the numbers are about 43 pounds per unit and 32 pounds per unit respectively.

I have no doubt that if it had been practicable in the turbine tests to use the full pressure of 140 pounds per square

inch for which the turbine was designed (in place of a pressure of 95 pounds) the consumption of steam per unit would have been considerably reduced.

As they stand, however, the results must be admitted to demonstrate a very remarkable performance. They show that in respect of economy of steam, and therefore of fuel, at full or moderately full load, the Parsons turbine of the type and size tested now challenges comparison with good engines of the usual kind, while its comparative freedom from friction gives it an exceptionally high efficiency when lightly loaded.

Apart from the question of steam economy, the lightness and compactness of the turbine dynamo, its small first cost, the perfect ease with which it is started, its freedom from vibration, and the absence of any need for heavy foundations, are points much in its favor as a generator for central station work.

Mr. Parsons has been good enough to give me every facility for examining the construction of his turbines and dynamos. I see no reason to anticipate that the charges for maintenance, for oil and for attendance will be larger than in the case of other engines. I should rather expect them to be lighter; and this appears to be borne out by the experience of the Newcastle and District Electric Lighting Company, where turbine generators have been in use for about two years.

I had the advantage of seeing the plant at that company's station and of obtaining particulars in regard to wages and other items of current outlay from the superintending engineer and the secretary of the company, who were most willing to supply information.

In regard to first cost, the turbine generator is probably cheaper, in large sizes, than any combination of ordinary engine and dynamo giving equal output. Mr. Parsons quoted to me the following prices for condensing turbines with dynamos, of either the alternating or continuous current type. The cost of the condensing plant is not included:—50-unit, £600; 100-unit, £850; 200-unit, £1,300.

The machine tested had an electrical governor which regulated by causing intermittent admission of steam. The action of this governor was not entirely satisfactory, and Mr. Parsons informed me that he meant to substitute for it a modified form of a type of governor which has been found to work well at the Newcastle and District Electric Light Station and elsewhere.

The turbine worked at its full load of 100 electrical units per hour without any sign of distress, and so far as could be judged was capable of giving a greater output without difficulty. The dynamo armature became hotter than is, in my opinion, desirable. This might be avoided by an alteration in the winding of the armature.

With a dynamo wound to give continuous currents, the consumption of steam in the turbine per electrical unit generated may be confidently expected not to exceed the consumption observed in these experiments.

Moonlight Tables for February, 1892.

Herewith we give Mr. H. W. Frund's table of lighting hours for the month of February, under his modified form of moon schedule:

TABLE NO. 1.
Standard Moonlight, Philadelphia System.

Date.	Light.	Date.	Exting.
1	5:50 P. M.	2	6:10 A. M.
2	5:50	3	6:05
3	10:25	4	6:05
4	11:40	5	6:05
5			
6	12:50 A. M.	6	6:05
7	2:05	7	6:05
8	3:10	8	6:00
9	4:10	9	6:00
10	5:00	10	6:00
11	No light.	11	No light.
12	No light.	12	No light.
13	No light.	13	No light.
14	6:05 P. M.	14	8:25 P. M.
15	6:05	15	9:30
16	6:05	16	10:25
17	6:05	17	11:25
18	6:10	19	12:25 A. M.
19	6:10	20	1:25
20	6:10	21	2:30
21	6:10	22	3:30
22	6:15	23	4:35
23	6:15	24	5:30
24	6:15	25	5:40
25	6:15	26	5:40
26	6:20	27	5:35
27	6:20	28	5:35
28	6:20	29	5:35
29	6:20	1	5:30

Total hours lighting, 180.30.

TABLE NO. 2.
Frund's New Moonlight System.

Date.	Light.	Date.	Exting.
1	5:50 P. M.	2	6:10 A. M.
2	5:50	3	6:05
2	5:50	4	6:05
4	5:50	5	6:05
5	5:55	5	12:00 M.
6	12:50 A. M.	6	6:05 A. M.
6	5:55 P. M.	6	12:00 M.
7	2:05 A. M.	7	6:05 A. M.
7	5:55 P. M.	7	12:00 M.
8	5:55	8	12:00
9	6:00	9	12:00
10	6:00	10	12:00
11	6:00	11	12:00
12	6:00	12	12:00
13	6:00	13	12:00
14	6:05	14	12:00
15	6:05	15	12:00
16	6:05	16	12:00
17	6:05	17	12:00
18	6:10	19	12:25 A. M.
19	6:10	20	1:25
20	6:10	21	2:30
21	6:10	22	3:30
22	6:15	23	4:35
23	6.15	24	5:30
24	6:15	25	5:40
25	6:15	26	5:40
26	6:20	27	5:35
27	6:20	28	5:35
28	6:20	29	5:35
29	6:20	1	5:30

Total hours lighting, 256.50.

On the Law of Hysteresis.*

BY CHAS. PROTEUS STEINMETZ.

I recently showed that in a set of determinations of the loss of energy due to hysteresis by reversals of magnetism, for different magnetizations, made by Ewing, this loss of energy due to hysteresis can fairly well be expressed by the equation:

$$H = \eta B^{1.6},$$

where H is the energy consumed by hysteresis during one magnetic cycle, in ergs per cubic centimetre, B the magnetization in lines of magnetic force per square centimetre, and η † a numerical coefficient, in this case = .002.

Considering that even the simple law of magnetism—that is, the dependence of the magnetization B upon the magnetomotive force F (for instance, in ampère turns per centimetre length of the magnetic circuit) has until now defied all attempts of mathematical formulation, it appeared a strange feature that the apparently much more intricate phenomenon of hysteresis, or rather of the consumption of energy by hysteresis, should yield to analytical formulation in such a simple way, to be directly proportional to the 1.6th power of the magnetization. At the same time the coincidence of Ewing's tests with the curve of the 1.6th power was near enough to be considered as something more than a mere incident, but at least as a clew to a law of hysteresis, the more as this law held not only for low and medium magnetization, but even for very high saturation, without showing any kink at that point where the magnetic characteristic goes over the bend or "knee" and thereby entirely changes its shape, nor any marked tendency of deviation of the extremest observed values from the calculated curve.

To study more completely this phenomenon of hysteresis and of the energy consumption caused thereby, I endeavored to make a number of determinations with different magnetic circuits and at different magnetizations. To be able to deal not only with the small amounts of energy which the reversal of magnetism in a tiny bit of iron wire sends through the ballistic galvanometer, but to reduce the determinations to readings of considerable power values, and where a much greater exactness can be reached, and at the same time to determine the dependence of the hysteretic loss of energy upon the velocity of the magnetic cycles, I decided to use alternating currents, at least as far as this could be done, whereby the determinations of the energy consumed by hysteresis is reduced to a simultaneous wattmeter, voltmeter, ammeter and speed reading.

At the same time this electro-dynamometer method has the advantage that the magnetic cycle is completed in a steady, continuous motion, while in the ballistic method the magnetic cycle is completed by sudden changes in the magnetization, which jumps from point to point, to enable the production of the induced current. This feature introduces an error into the ballistic method, for if a magnetic cycle is gone through by sudden changes, a larger amount of energy may be consumed than if the magnetization varies steadily in harmonic vibration.

Suppose, around a magnetic circuit, an alternating current of N periods per second is sent in n convolutions.

Let C = the effective strength of the current,

E = the effective E. M. F. induced in the circuit by self-induction, after subtracting the E. M. Fs. induced by the self-induction of the instruments

W = the energy consumed in the circuit, after subtracting the energy consumed by the resistance.

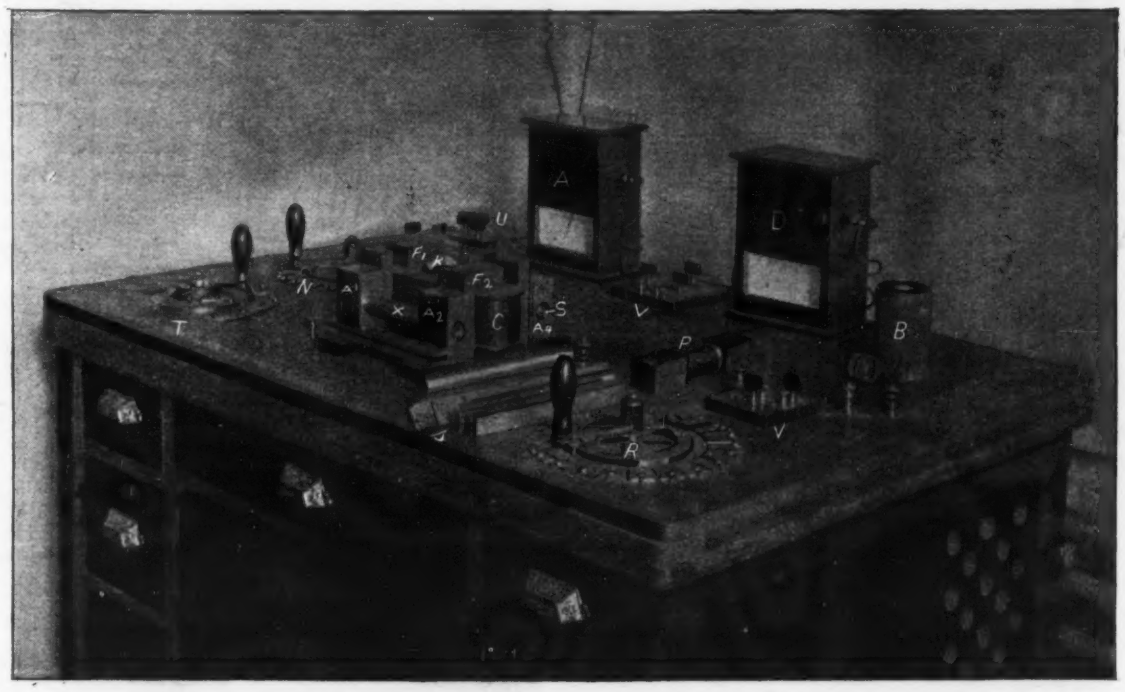


FIG. 1. THE EICKEMEYER DIFFERENTIAL MAGNETOMETER.

Then, l being the length and s the cross section of the magnetic circuit, all in centimetres, ampères, volts, watts, etc.,

Let B = the maximum magnetization in lines of magnetic force per square centimetre,

H = the loss of energy by hysteresis per cycle and cubic centimetre; it is

$$W = l\, s\, N\, H \times 10^{-7}$$

hence

$$H = \frac{W}{l\, s\, N} \times 10^{-4}$$

the hysteretic loss of energy, and

$$E = \sqrt{2}\, \pi\, s\, B\, N\, n \times 10^{-8}$$

hence

$$B = \frac{E \times 10^{+8}}{\sqrt{2}\, \pi\, s\, N\, n} \quad *$$

the maximum magnetism.

For higher frequencies, 80 to 200 periods per second, the alternating current was derived from a 1-h. p. 50-volt Westinghouse dynamo. This was driven by a 3-h. p. Eickemeyer continuous current motor. By varying the excitation of the motor field and varying the E. M. F. supplied to the motor, the speed and therefore the frequency of the alternating current could be varied in wide limits. At the same time, supplied with constant E. M. F. and like all the Eickemeyer motors of unusually small armature reaction, this electromotor kept almost absolutely constant speed under varying load, the more as it never ran with full load.

For low frequencies this bipolar continuous current motor was used as a bipolar alternating dynamo, as shown in a patent of Mr. Stephen D. Field. On the continuous current commutator two sliding rings were mounted and connected with opposite commutator bars. In the ordinary continuous current brushes a continuous current was sent in, which set the machine in motion as an electromotor, while from the sliding rings by two separate brushes alternating currents were taken off. By varying the E. M. F. supplied to the motor, the E. M. F. of the alternating current was varied, while a variation of the motor field gave the variations of the frequency. The curve of E. M. F. was very nearly a sine wave, the ratio of maximum E. M. F. to effective E. M. F. found = 1.415, while the sine wave requires 1.414—that is, exactly the same.

To determine whether the change of the shape of the alternating current by varying load and varying excitation had any influence upon the readings, the variations of the alternating E. M. F. were produced.

1. By varying the excitation of the field of the Westinghouse dynamo.

2. By running the Westinghouse dynamo fully excited feeding the secondaries of a bank of converters, feeding from the fine wire coils of these converters the fine wire coils of another bank of converters, and taking current off from the secondaries of these converters, connected from one to six in series.

3. By changing the E. M. F. by means of a Westinghouse converter of variable ratio of transformation.

4. By loading the dynamo when small currents were used for the tests.

But after having found that all these different ways of varying the alternating E. M. F. give no perceptible difference whatever in the readings, I afterward used the most convenient way to vary the excitation of the dynamo field and, where higher E. M. Fs. were needed, to increase the E. M. F. by an interchangeable converter, which gave the ratio: 1 : 1, 2. 3, 4, 5.

The first sets of tests were made on the magnetic circuit of a small Westinghouse converter.

The constants of this converter, so far as they are of interest here, are:

Main length of magnetic circuit, 21 centimetres.

Mean cross-section of magnetic circuit, = 43.67 cm².

Hence volume of iron = 917 cm³.

Resistance of secondary coil = .2 ω

Further sets of readings were taken on a magnetic circuit, built up of very thin sheets of iron, alternately 8 in. × 1 in. and 3 in. × 1 in., in rectangular shape, very carefully insulated against eddy currents with layers of thin paper between the sheets. On the two long sides two coils, of each 50 turns, very coarse wire (3 No. 10 in parallel) were wound and connected in series, thereby giving n = 100 turns of an internal resistance of .048 ω.

Here the mean length of the magnetic circuit was l = 41 cm.

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* Abstract of a paper read before the Am. Inst. of Elec. Eng.

† If any quantity has a right to be called "magnetic resistance" it is this coefficient η; for η is the *coefficient of conversion of magnetic energy into heat*, while as "electric resistance" we define the *coefficient of conversion of electric energy into heat.*

The term generally denoted "magnetic resistance"—that is, the inverse value of magnetic susceptibility—does not deserve this name at all, but is more properly called "reluctance."

* This formula holds rigidly only for the sine wave, but as shown in the following, the currents used in the tests were at least very near sine waves. Besides, a deviation from the sine shape would not alter the results at all, but only slightly change the coefficient.

The cross-section, $s = 3.784$ cm.^{2}

The circuit consisted of 58 layers of sheet iron of the thickness $s = .02577$ * and the width $w = 2.579$.

The whole volume of iron was $= 155$ cm.^{3}

The sheet iron pieces were first freed from scales by dipping into dilute sulphuric acid.

In one set of tests an open magnetic circuit was used, by leaving the short end pieces (3 in. $\times$1 in.) off, and using two piles each of 66 pieces (8 in. $\times$ 1 in.) of the same iron, the same pieces as used in the former closed circuit tests.

In these readings, for the determination of the hysteretic loss, only voltmeter and wattmeter, but no ammeter, were used, and the susceptibility curve determined separately by voltmeter and ammeter.

The calculation of the reading was done in the following way:

After applying the corrections for self-induction of instruments, resistance and speed, the readings were reduced to lines of magnetic force per square centimetre B and consumption of energy by hysteresis per magnetic cycle H, in ergs.

Then the results were plotted on cross-section paper, and if any value was found to be very much out of the curve connecting the other values, it was stricken out as evidently erroneous, not considering it worth while to determine whether it was a wrong reading of any one of the instruments or a mistake in the calculation.

Then from the other values of B and H, under the supposition that H were proportional to any power x of B:

$$H = \eta B_x$$

this exponent x was determined.

This value x will be seen always to be so near to 1.6 that 1.6 can be considered at least as first approximation to x.

Then, under the assumption

$$x = 1.6$$

hence

$$H = \eta\, B^{1.6}$$

the coefficient η was calculated, and now the equation

$$H = \eta\, B^{1.6}$$

plotted in a curve, as given in the figures, and the observed values of H drawn in and marked.

From the curve were taken the calculated values of H, corresponding to the observed values of B, the difference

$$H_{\text{calc}} - B_{\text{obs}}$$

determined, and expressed in per cents. of H_{calc}.

These values are given in the tables and shown in the curves.

MAGNETIC CIRCUIT OF THE WESTINGHOUSE CONVERTER.

TABLE I.

MAGNETIC CHARACTERISTIC.

F = M. M. F. in ampère turns per centimetre length of magnetic circuit.

B = Magnetization, in lines of magnetic force per square centimeter.

F.	B.	F.	B.	F.	B.
2	1,500	12	14,750	45	18,150
3	3,400	14	15,080	50	18,500
4	6,800	16	15,370	55	18,820
5	9,600	18	15,630	60	19,140
6	11,750	20	15,880	65	19,440
7	12,850	25	16,450	70	19,740
8	13,600	30	16,950	75	20,020
9	14,100	35	17,370	80	20,300
10	14,350	40	17,780	85	20,560
				90	20,820

HYSTERESIS.

B = Magnetization, in lines of magnetic force per square centimetre.

H = Loss of energy by hysteresis, in ergs per cycle, and cubic centimetre $= 10^{-7}$ watt-second.

TABLE II.

Frequency: $N = 137$ complete periods per second:

B.	H. obs.	H. calc.	$H_{\text{calc}} - H_{\text{obs}}$ =	Per cent.
4,000	1,490	1,410	− 80	−5.7
4,670	1 818	1.800	− 18	−1.0
5,510	2,358	2,350	− 8	− .3
5,760	2.482	2,520	+ 38	−1.5
5,840	2.540	2,580	+ 40	+1.6
6,690	3,285	3.180	−105	−3.3
6,800	3,358	3.290	− 68	−2.1
6,860	3,374	3.370	− 4	− .1
12,430	8,336	8,610	+274	+3.6
13,750	10,000	10,100	+100	+1.0
		average	±73.5 =	±2.0

Exponent of power, derived from tests:

$$x = 1.5887 \sim 1.6$$

Coefficient of hysteresis:

$$\eta = .002438$$

hence, theoretical curve:

$$H = .002438\, B^{1.6}$$

From four sets of reading we get the results:

1. $N = 28$ 4 readings: $x = 1.6111$ $\eta = .002410$
2. 36 5 " 1.6476 .002315
3. 137 10 " 1.5887 .002438
4. 205 18 " 1.6012 .002434

Therefrom we derive the average, by giving to each value as weight the number of readings, where it is based upon:

$$x = 1.60513 \sim 1.6$$

$$\eta = .0024164$$

Hence

$$H = .0024164\, B^{1.6}$$

* Calculated from the weight.

HYSTERESIS.

B = magnetization in lines of magnetic force per square centimetre.

H = loss of energy by hysteresis, in ergs per cycle and cubic centimetre, $= 10^{-7}$ watt-seconds.

TABLE III.

Frequency, $N = 138$ complete periods per second.

B.	H. obs.	H. calc.	$H_{\text{calc}} - H_{\text{obs}}$ =	Per cent.
5,220	3.030	3,015	− 15	− .5
5,750	3,62)	3.550	− 70	− 1.9
6,540	4,320	4,355	+ 35	+ .8
7,070	4,830	4.890	+ 60	+ 1.2
8,210	5,950	6,160	+ 210	+ 3 4
8,520	6,090	6,530	+ 440	+ 6.7
9,570	7,850	7,840	− 10	− .1
10,450	8,780	9,040	+ 260	+ 2.9
11,990	11,060	11,230	+ 170	+ 1.5
14,570	15,840	15,340	− 500	− 3.3
14,660	16,16)	15,580	− 580	− 3.7
16,770	20,350	19,260	−1,090	− 5.6
17,970	20,620	21,440	+ 820	+ 3.9
19,320	23,180	24,120	+ 940	+ 3.8
		average	± 371 =	± 2.8

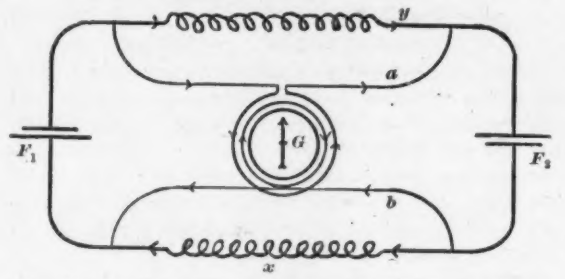

FIG. 2.—DIAGRAM OF EICKEMEYER MAGNETOMETER.

Exponent of power, derived from tests:

$$x = 1.6044 = 1.6.$$

Coefficient of hysteresis:

$$\eta = .00335;$$

hence theoretical curve:

$$H = .00335\, B^{1.6}$$

OPEN MAGNETIC CIRCUIT.

Two gaps of $\sim$ 4 cm. length.

TABLE IV.

Frequency, $N = 138$ complete periods per second.

B.	H. obs.	H. calc.	$H_{\text{calc}} - H_{\text{obs}}$ =	Per cent.
3,150	1,570	1.560	− 10	− .6
3,640	2,110	2,020	− 90	− 4.4
4,690	2,930	2.950	+ 20	+ .7
5,490	3,510	3,780	+ 270	+ 7.2
6,270	4,380	4,690	+ 310	+ 6.6
10,250	10,450	10,290	− 160	− 1.6
11,000	11,810	11,520	− 290	− 2.5
12,280	14,250	13,740	− 510	− 3.7
		average	± 208	± 3.4

Exponent of power derived from tests:

$$x = 1.6040 \sim 1.6$$

Coefficient of hysteresis:

$$\eta = .00394$$

hence theoretical curve:

$$H = .00394\, B^{1.6}$$

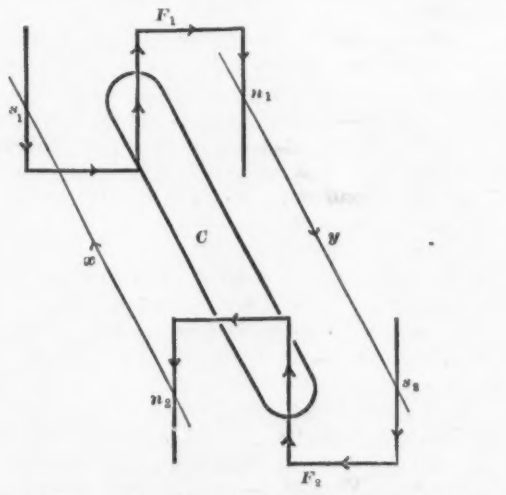

FIG. 3.—DIAGRAM OF EICKEMEYER MAGNETOMETER.

From four sets of readings at different frequencies we get the results:

CLOSED MAGNETIC CIRCUIT.

$N = 85$ 9 readings: $x = 1.6041$ $\eta = .00285$

138 14 " 1.6044 .00335

205 9 " 1.6970 .00373

OPEN MAGNETIC CIRCUIT.

$N = 138$ 8 readings: $x = 1.6040$ $\eta = .00393$

Herefrom it seems that the consumption of energy by hysteresis per magnetic cycle increases with increasing frequency—that is, with increasing velocity of the magnetic change.

The three values of three coefficients of hysteresis for closed circuit in their dependence upon the frequency N can be expressed by the empirical formula:

$$\eta = (.0017 + .000016\, N - .00000003\, N^2)$$

Especially noteworthy is the last set of readings, on open magnetic circuit, in so far as it proves the fallacy of the general opinion that the hysteretic loss of energy in the iron is smaller in the open magnetic circuit than in the closed circuit.

For the coefficient of hysteresis observed on open magnetic circuit

$$\eta = .00393$$

is even greater than that for closed magnetic circuit,

$$\eta = .00335$$

But this discrepancy is easily explained by the fact that in the closed magnetic circuit the magnetization is nearly uniform throughout the whole iron. But in the open magnetic circuit the magnetic field intensity differs considerably from point to point, being a maximum in the middle of the magnetizing coils and a minimum at the ends of the iron sheets. Now the values of B given in the table are the average values of the magnetization, and the values H the average values of hysteretic loss. But the average value of the 1.6th powers of different quantities B is larger than the 1.6th power of the average value of B.

For instance, in a cubic centimetre of iron magnetized to $B = 12{,}000$, $H = 10{,}080$; in a cubic centimetre of iron magnetized to $B = 6{,}000$, $H = 3{,}330$; hence of these two cubic centimetres the average magnetization is

$$B = 9{,}000, \text{ and the average } H = 6{,}705 \text{ ergs,}$$

but to $B = 9{,}000$ corresponds $H = 6{,}360$ ergs; that is about five per cent. less, and the difference becomes still greater if the values B differ still more.

Taking this into account, it seems that the loss of energy due to hysteresis depends only upon the intensity of magnetization, and perhaps upon the frequency, but is independent of open or closed magnetic circuit, as is to be expected.

A third set of determinations of the hysteretic loss of energy is given in the following:

Again a magnetic circuit was built up of 17 layers of a soft kind of sheet iron, each layer consisting of two pieces of 20 centimetres length, and 2.54 centimetres width, and two pieces of 7.6 centimetres length and 2.54 centimetres width, of the thickness $\delta = .0686$ centimetre.

Here evident proof of the induction of eddy currents in the iron was found. Especially perceptible was a decrease in the watts consumed by the iron, when a larger M. M. F. of high frequency was left acting upon the iron. This decrease must be attributed to the increase of the electric resistance of the iron, caused by its increasing temperature.

The method of determination, the apparatus, etc.*, were the same as in the second set of tests, only that ammeter, voltmeter and wattmeter were used at the same time. In calculating these tests, the law of the 1.6th power was assumed as true, and the loss of energy in the iron expressed by the equation,

$$H = \eta\, B^{1.6} + \varepsilon\, N\, B^2$$

where

$$H_1 = \eta\, B^{1.6}$$

is the true hysteretic loss per cycle and cm.^{3}, which is independent of the frequency, and

$$H_2 = \varepsilon\, N\, B^2$$

is the loss of energy by eddy current, per cycle, which is proportional to the frequency N.

From this expression

$$H = H_1 + H_2$$

the coefficients η and ε were calculated and the agreement or disagreement of these coefficients η and ε allows us now to check the correctness or incorrectness of the law of the 1.6th power.

These tests gave the following results:

HYSTERESIS.

B = magnetization in lines of magnetic force per square centimetre.

H = loss of energy by hysteresis, in ergs per cycle η ch-cm. $(= 10^{-7}$ joules$) = H_1 + H_2$.

$H_1 = \eta\, B^{1.6}$ = loss of energy by hysteresis proper, in ergs per cycle and cm.^{3} $(= 10^{-7}$ joules).

$H_2\ \varepsilon\, N\, B^2$ = loss of energy by eddy currents, in ergs per cycle and cm.^{3} $(= 10^{-7}$ joules).

TABLE V.

Frequency, $N = 140$.

$\eta = .00331$ $\varepsilon = .730 \times 10^{-6}$

B.	H_1	H_2	H. (1) calc.	H. obs.	Δ	= Per cent.
4,880	2,650	2,720	5,360	5,280	+ 80	+ 1.5
6,780	4,490	5,270	9,760	9,420	+ 340	+ 3.4
7,720	5,530	6,830	12,360	12,000	− 240	− 1.9
10,200	8,640	11,940	20,580	12,400	+ 180	+ .9
12,080	11,300	16,700	28,000	29,100	−1100.	− 4.0
17,200	19,860	33,840	53,700	53,000	+ 700	+ 1.3
				average	{+7.1 / −5.9}	± 2.2 (+.2)

The values found for η are so nearly alike that we consider them as constant, and take their mean value

$$\eta = .00333$$

as the coefficient of hysteresis.

Even the values found for ε are not much different from each other, not more than was to be expected from the unavoidable differences in the temperature of the iron, which, because of the high electric temperature-coefficient of iron, makes ε rather variable.

Taking the average of ε, we derive

$$\varepsilon = .746 \times 10^{-6}$$

and as formula of iron loss,

$$H = .00333\ B^{1.6} + .746 \times 10^{-6}\ N B^{2}$$

MAGNETOMETER TESTS.

The method used in the foregoing has the great advantage that,

1. It allows the taking of a greater number of readings, over a wide range of magnetization, in a short time, by mere simultaneous instrument readings, and thereby reduces the probable error by increasing the number of observations.

2. It allows the use of electro-dynamometers, as the most reliable electric measuring instruments.

3. It deals with larger amounts of energy, counting by watts or even hundreds of watts, whereby a much greater accuracy can be reached than by the ballistic galvanometer.

4. It measures the hysteresis under the influence of an harmonically, and not suddenly, varying M. M. F., that is, under the same conditions, where it becomes of importance for practical engineering.

But it has the great disadvantage that it can be used only for testing sheet iron or other thoroughly laminated iron, where eddies are either inappreciable or can be calculated also. For testing solid iron and steel pieces, this method cannot be used, because of the tremendous amount of eddies which flow in a solid piece of iron.

To determine the hysteretic loss of energy in steel and cast iron the Eickemeyer differential magnetometer was used. In Figs. 2 and 3 are diagrams of its action.

The principle of this instrument resembles somewhat the principle of the well known differential galvanometer applied to the magnetic circuit. In Fig. 2, suppose F_1 and F_2 were two E. M. Fs. connected in series; for instance, two cells of a battery x and y, the two resistances which we want to compare. Either resistance x and y is shunted respectively by a conductor a and b of equal resistance, which influences a galvanometer needle G in opposite directions, but with equal strength.

Then the zero position of the needle G shows that the electric current c_a, flowing in a, is equal to the current c_b in b. But let the current in x be c_x, and in y, c_y; then we must have

$$c_a + c_y = c_b + c_x,$$

because the currents c_a and c_y are the two branches of the same integral current as c_b and c_x.

Therefore, if $c_a = c_b$, then

$$c_x = c_y.$$

But if $c_a = c_b$, and $a = b$, the difference of potential at the ends of a (or, what is the same thing, y) is equal to the difference of potential at the ends of b or x, and, therefore, the current in x and, y, and, the potential differences being the same, it follows that $x = y$.

That is, this method of connection allows us to compare an unknown resistance x with a standard resistance y.

Now, instead of "electric current," say "magnetic current" or "number of lines of magnetic force;" instead of "electromotive force" or "potential difference," say "magneto-motive force;" and instead of "electric resistance," say "magnetic resistance," and we have the principle of this instrument.

Its magnetic circuit consists of two pieces of best Norway iron ⊓⊔ shaped, shown in the illustration of the complete instrument, Fig. 1, and in the diagram, Fig. 3, at F_1 and F_2. The middle portion is surrounded by a magnetizing coil C. Therefore, if coil C is traversed by an electric current, the front part s_1 of the left iron piece becomes south, and the back part n north polarity. The front part of the right iron piece n becomes north and the back part south; and the lines of magnetic force travel in the front from the right to the left, from n_2 to s_1; in the back the opposite way, from the left to the right, or from n_1 to s_2, either through the air or, when n_2 and s_1 or n_1 and s_2 are connected by a piece of magnetizable metal, through this and through the air.

In the middle of the coil C stands a small soft iron needle with an aluminium indicator, which plays over a scale K, and is held in a vertical position by the lines of magnetic force of the coil C itself, deflected to the left by the lines of magnetic force traversing the front part of the instrument from n_2 to s_1 deflected to the right by the lines traversing the back from n_1 to s_2. This needle shows by its zero position that the magnetic flow through the air in front from n_2 to s_1 has the same strength as the magnetic flow in the back from n_1 to s_2 through the air.

Now we put a piece of soft iron x on the front of the instrument. A large number of lines go through x, less through the air from n_2 to s_1, but all these lines go from n_1 to s_2 through the air at the back part of the magnetometer, the front part and back part of the instrument being connected in series in the magnetic circuit. Therefore the needle is deflected to the right by the magnetic flow in the back of the instrument.

Now we put another piece of iron, y, on the back part of the instrument. Then equilibrium would be restored as soon as the same number of lines of magnetic force go through x as through y, because then also the same number of lines go through air in the front as in the back. As will be noted, the air here takes the place of the resistances a and b, influencing the galvanometer needle G, as in the diagram, Fig. 2.

(To be continued.)

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Chronological History of Electricity, Galvanism, Magnetism and the Telegraph, from B. C. 2637 to A. D. 1888.—Part I.

BY P. F. MOTTELAY.

At the close of Richard Fowler's "Experiments and Observations, etc.," Edinburgh, 1793, is a letter from Prof. Robison, wherein he gives the results of many curious investigations, mostly made upon himself, to ascertain the effects of the galvanic influence. He found the latter well defined on applying one of two metallic substances to a wound which he had accidentally received; discovered by their tastes the solders in gold and silver trinkets; and showed that the galvanic sensation can be felt when the metallic substances are placed at a distance from each other. He proved the last named fact by placing a piece of zinc between one of the cheeks and the gums, and a piece of silver on the opposite side within the other cheek. He next introduced a zinc rod between the piece of zinc and the cheek on the one side, and a silver rod between the silver and the cheek on the other, and when he afterward carefully brought into contact the extremities of the rods outside the mouth a flash appeared and a powerful sensation was noticeable in the gums. He experienced the same sensation when he again separated the rods and brought them to a short distance from each other, but he could perceive no galvanic effect when he placed the rods (or wires) in such manner that the silver rod should touch the zinc or the zinc rod touch the piece of silver. He also ascribed to galvanic effect the well known fact that the drinking of porter out of a pewter pot produces a more brisk sensation than when it is taken out of a glass vessel. In this instance, he says there is a combination of one metal and of two dissimilar fluids. In the act of drinking, one side of the pewter pot is exposed to the saliva and the humidity of the mouth, while the other metallic side is in contact with the porter. In completing the circuit, in the act of drinking, a brisk and lively sensation arises, which imparts an agreeable relish to the liquid. He, likewise, observed that the conducting power of silk thread depends greatly on its color, or rather on the nature of its dye. When of a brilliant white, or a black, its conducting power is the greatest; while either a high golden yellow or a nut brown renders it the best insulator. Human hair, when completely freed from everything that water could wash out of it, and then dried by lime and coated with lac, was equal to silk.

Robison's last publication was made in 1804, one year before his death, and constituted the first part of a series which was to appear under the head of "Elements of Mechanical Philosophy." This portion, together with some MSS. intended for the second part, and his principal articles contributed to the "Encyclopædia Britannica," were collected in 1822 by David Brewster, LL.D., and published with notes, in 4 vols. under the title of "System of Mechanical Philosophy."

See Playfair in "Transactions of the Royal Society of Edinburgh," vol. VII., page 495; Stark's "Biographia Scotica;" *Philosophical Magazine*, vol. XIII.; Aikin's "General Biography," London, 1813, vol. VIII.; Dr. Gleig in *Anti-Jacobin Magazine* for 1802, vol. XI.; Chalmer's "Biographical Dictionary," London, 1816, vol. XXV.; Dr. Thomas Young, "Course of Lectures," London, 1807, vol. II., pages 438, 444.

A. D. 1793.——Professor Hildebrand, of Erlang, makes important observations relative to the influence of form and of substance upon the electric spark. He finds, among other results, that an obtuse cone with an angle of 52 degrees gives a much more luminous spark than one with an angle of only 36 degrees. That the greater sparks are given by conical pieces of regulus of antimony and the least by tempered steel. Also, that when the spark is *white* by taking it with a metallic body, it will, under the same circumstances, be *violet* if taken with the finger, that if the spark is taken with ice or water, or a green plant, its light will be red, and, if it is taken with an imperfect conductor, such as wood, the light will be emitted in faint red streams.

See "Encyl. Britannica," vol. VIII., 1855, pp. 544, 545.

A. D. 1794.——Read (John), mathematical instrument maker, at the Quadrant, at Kingsbridge, Hyde Park, gives, in his "Summary View of the Spontaneous Electricity of the Earth and Atmosphere," the result of a very elaborate series of observations, which he continued almost hourly between the years 1791 and 1792. Of 987 trials, he found that 664 gave indications of positive electricity, and out of 404 trials made in one year, the air was positively electrical in 241, negatively in 156, and insensible in only seven observations. He also found the vapor near the ground, in the act of condensing into dew, always highly electric.

He made many observations upon the electricity of vegetable bodies, which were afterward developed by Mr. Pouillet, and it was also Mr. Read who introduced a new hand-exploring instrument as well as an improved fixed thunder rod for collecting atmospherical electricity. These are described at page 608 of the Eighth volume of the 1855 "Encyclopædia Britannica."

According to Mr. Wilkinson ("Elements of Galvanism, etc.," London, 1804, vol. II., p. 344), Mr. Read was the first to apply the apparatus called the condenser to the electroscope to the end that it should evince small intensities of electricity.

See *Philosophical Transactions*, for 1791, page 185; for 1792, page 225; for 1794, pages, 185, 266; Cavallo, "Nat. Phil.," 1825, vol. II., page 226; Young's "Course of Lectures," vol. I., page 714; Ed. Peart, "On Electric Atmospheres . . .," Gainsboro, 1793; Eng. Ency., "Arts and Sciences," vol. III., page 805; Thomas Thomson, "Outline of the Sciences," 1830, page 446; *Journal de Physique* for 1794, vol. XLV., page 468.

A. D. 1794.——Chladni (Ernst Florens Friedrich), founder of the theory of acoustics, publishes "The Iron Mass of Pallas, etc." ("Ueber don Ursprung . . .") giving a list of recorded cases of the fall of meteorites or aërolites and all the important accounts of such that he was able to collect. As Prof. Alexander Herschel informs us, in his lecture, delivered (1867) before the British Association at Dundee, Chladni conceived that a class of cosmical bodies exists in all parts of the solar system, each forming by itself a peculiar concourse of atoms, and that the earth from time to time encounters them, moving with a velocity as great as its own, and doubtless in orbits of very various eccentricity around the sun. By their exceeding great velocity, Prof. Muirhead says, which is increased by the attraction of the earth and the violent friction of the atmosphere, a strong electricity and heat must necessarily be excited, by which means they are reduced to a flaming and melted condition, and great quantities of vapor and different kinds of gases are thus disengaged, which distend the liquid mass to a monstrous size, until, by still further expansion of these elastic fluids, they must at length explode. (Chladni's hypothesis in "Enc. Brit.," article "Meteorolite.")

Humboldt gives ("Cosmos," London, 1849, vol. I, Note page 104) the following upon the same subject, taken from Biot's "Traité d'Astronomie Physique," third edition, 1841, vol. I, pp. 149, 177, 238, 312: "My lamented friend Poisson endeavored in a singular manner to solve the difficulty attending an assumption of the spontaneous ignition of meteoric stones at an elevation where the density of the atmosphere is almost null. These are his words: 'It is difficult to attribute, as is usually done, the incandescence of aërolites to friction against the molecules of the atmosphere, at an elevation above the earth where the density of the air is almost null. May we not suppose that the electric fluid, in a neutral condition, forms a kind of atmosphere, extending far beyond the mass of our atmosphere, yet subject to terrestrial attraction, although physically imponderable, and consequently following our globe in its motion?' According to his hypothesis, the bodies of which we have been speaking would on entering on this imponderable atmosphere decompose the neutral fluid by their unequal action on the two electricities, and they would thus be heated, and in a state of incandescence, by becoming electrified." (Poisson, "Rech. sur la Probabilité des Jugements," 1837, p. 6.)

The theories advanced by Chladni were confirmed four years later, by Brandes and Benzenberg at Göttingen, and, during the month of April, 1809, he inserted a Catalogue of Meteors in the "Bulletin de la Société Philomathique," which was followed by a paper on Fiery Meteors published at Vienna in 1819.

In his "Traité d'Acoustique," Chladni treats of the line of experiments to which he was led, as well by the discovery of Lichtenberg's electric figures (see A. D. 1777, and Tyndall, "Sound," Lecture IV.), an account of which latter appeared in the "Mémoires de la Société Royale de Göttingen," as through the suggestions made him by Lichtenberg himself during the year 1792 relative to the origin of meteors. The results of Chladni's researches concerning the last named, appeared in a Memoir published at Leipsic during 1794, translated by Mr. Eugène Coquebert Mombret for vol. V. of the *Journal des Mines*.

It may here be properly added that, in one of the editions of his Lectures on Sound, Professor Tyndall gives a portrait of Chladni and quotes a letter received from Professor Weber wherein he says: "I knew Chladni personally. From my youth up he was my leader and model as a man of science, and I can not too thankfully acknowledge the influence which his stimulating encouragement during the last years of his life had upon my own scientific labors."

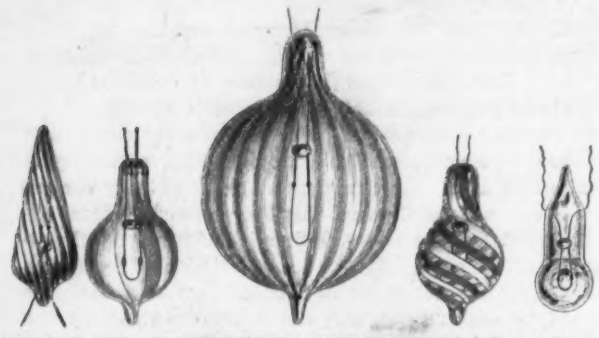
See Humboldt's "Cosmos," London, 1849, vol. I., p. 104 (M. Schreiber), pp. 113, 114 (M. Capocci), also pp. 105, 108, 110, 121, and the entire "Review of Natural Phenomena," with all the important references and notes thereunto attached. See, likewise, Peter Simon Pallas (*Phil. Trans.* for 1776 and "Act. Acad. Petrop." I., for 1778); Chladni's "Uber . . . elektricität einer Katze," Jena, 1797; J. Acton and Capel Lofft, in *Phil. Magazine*, vol. LI., pp. 109, 203; F. B. Albinus "Specimen, etc.," 1740; Voigt's "Magaz.," I., 1797; Schweigger's Journal, XLIII., 1825; H. Atkinson, "On Hypotheses, etc. (*Phil. Mag.*, vol. LIV., p. 337; Kerstner, *Archiven*, vol. IV.; F. C. Von Petersdorff in "Great Divide," Pierre Prevost and others in Poggendorff's *Annalen*, vol. II., VI. and VII.; Arago, "Annuaire pour 1826;" D. Avelloni "Lettera, etc.," Venezia, 1760; Martin H. Klaproth's different memoirs published at Berlin 1795–1809; Joseph Izarn, "Lithologie Atmosphérique;" J. Murray (*Phil. Mag.*, vol. LIV., p. 39); beside Chladni's works in conjunction with Karl F. Anton von Schreibers, Wien, 1819 and 1820, and with Messrs. Steininger and Naeggerath, London, 1827 (Schweigger's *Journal*, N. R. XVI., 385, and *Phil Mag.*, vol. II., p. 41, also vol. IV., p. 332).

Incandescent Lamp Novelties.

The accompanying illustrations show a number of styles of miniature incandescent lamps of low voltage, some of which are novel, and as such are in considerable demand.

Fig. 6 is a "prism" lamp. It is mounted upon a chandelier, and when lit produces a most beautiful display of rainbow colors. The effect is said to be far superior to that of the prisms suspended from a gas chandelier.

A "torch" lamp (Fig. 8) is another one designed for purposes of theatrical display, etc. It has four lenses fused on to it, and all the surface around them is frosted. The effect of this combination of a true spheroidal form of the globe with frosting and lenses is to project the light in the form



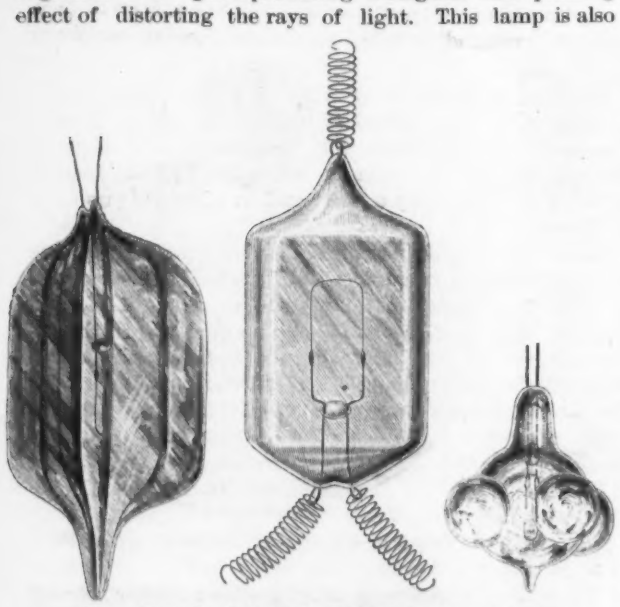
FIGS. 1 TO 5.—SOMOFF'S INCANDESCENT LAMPS.

of four condensed beams. Last December 450 of these lamps were shipped to order of a theatrical company to be used in the production upon European stages of the opera "Robert le Diable." The lamps were mounted on torches, which contained small storage batteries. Little vanes at the bases of the lamps revolved with the least motion of the air and revolved the lamps, the beams of light striking in every direction. This lamp is also most suitable for models of the Statue of Liberty, of a lighthouse, or for locomotive headlights, etc.

Fig. 7 is a "lantern" lamp, English pattern. The storage battery lanterns as made and extensively used in England and in large numbers imported into the United States have a very shallow reflector and the bull's-eye quite close to it. There is no room for any other but a flat lamp. The lamp is suspended from three springs, two of which constitute the terminals. This method of mounting lamps in lanterns is, as practiced, considered far preferable to any other.

Fig. 1 is a "miniature candle" lamp whose globe is of corrugated and gently twisted glass.

Fig. 3 represents a "corrugated sphere" lamp, the corrugations of the globe producing a singular and pleasing effect of distorting the rays of light. This lamp is also



FIGS. 6 TO 8.—SOMOFF'S INCANDESCENT LAMPS.

made with the channels of the globe plated with silver, so that it presents a large number of alternate strips of crystal glass and mirrors, and looks then as if thousands of filaments are inclosed within the globe.

Figs. 2 and 4 are "striped" lamps, the stripe being alternately red, blue, milk-white and crystal. These lamps are especially suitable for flower bouquets, flower baskets and flower decorations in general. Placed in the centre of a flower the lamps assume the color of the latter, the colored stripes greatly adding to the effect.

Fig. 5 is a surgical lamp of English design. For its neat shape and for the effect which all incandescent lamps of very small size have upon people of limited electrical knowledge it is called a "fairy" lamp.

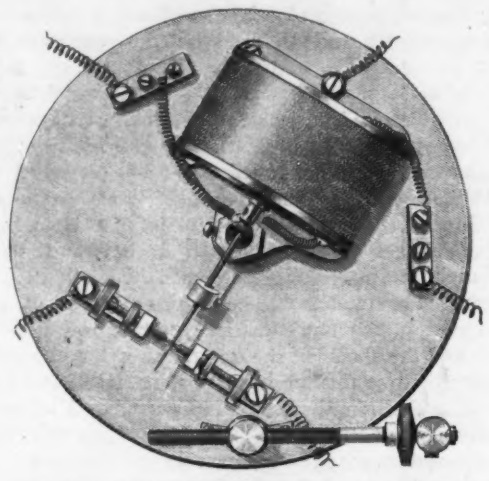
The lamps are designed and are being placed upon the market by Mr. J. L. Somoff, of No. 1 Ann street, New York.

The Ritchie Potential Indicator.

A necessary adjunct to an electric lighting station is an instrument for indicating the variation of pressure of the current in the mains, it being essential to the successful working of an incandescent system that the potential should be maintained as nearly constant as possible. The accompanying illustration shows the Ritchie potential indicator designed for this purpose.

It is mounted upon a circular slate base, secured to the wall or switchboard by a bolt about which it turns, and is constantly in circuit. The moving parts, completely enclosed by the large coil, are fully protected from dirt and dust, the index arm alone projecting below to the contacts.

The instrument works against gravity and the adjustment is made by means of the tangent screw. Red and green lamps are in circuit with the contact points and in-



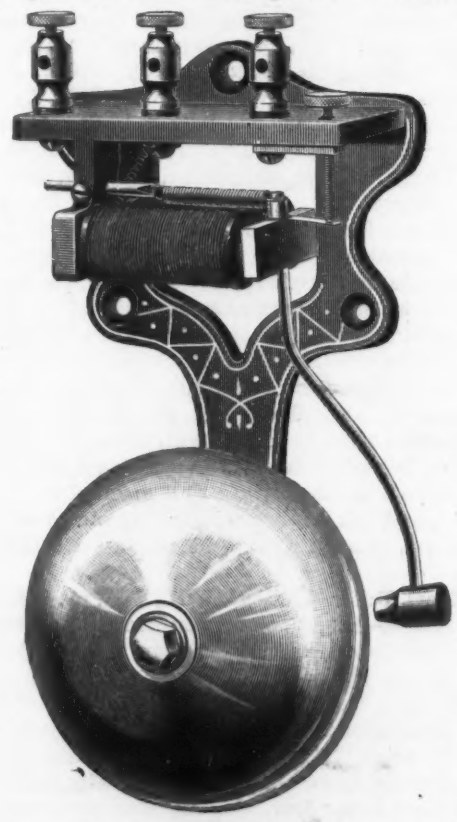
RITCHIE'S POTENTIAL INDICATOR.

dicate high and low respectively, the proper pressure being shown when neither are lighted.

After extended tests, under most severe conditions, the indicator, it is stated, is found to be free from error due to the vibrations of building or board common to most stations, and is guaranteed to work within one-half volt each way above and below the voltage to which it may be adjusted. It is also made without the contacts and lamps, the pointer indicating on a graduated card simply, high, low, or right. It is being manufactured and put upon the market by E. S. Ritchie & Sons, Brookline, Mass.

The Berlin Bell.

The illustration shows an improved skeleton bell, in which the armature is hung on two pins attached to the magnet cores. The rapidity of its blows can be varied at will, according to the distance between the adjusting screw and the platinum tipped contact piece. There is a rubbing contact between the adjusting screw and the circuit breakers, which insures a bright surface at all times. It is so constructed that it cannot get out of adjustment, as the circuit must be broken and completed, whatever the length of the stroke may be. It has three binding posts so connected that it is either continuous ringing or single stroke as preferred. A heavy hammer, long stroke and powerful mag nets make it a valuable tap bell on fire alarm circuits. It is furnished in all sizes, from four to 12 inches, and is well made, only the best material being used in its construction.



THE BERLIN ELECTRIC BELL.

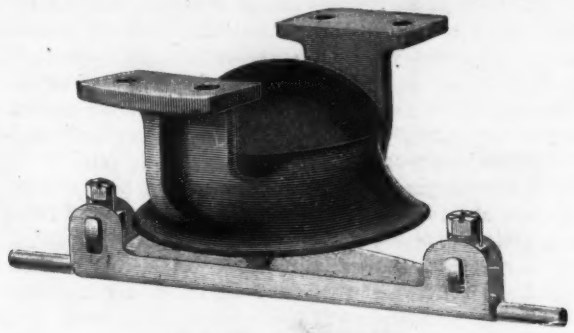
All working parts are well insulated except the armature, which is copper plated. Its iron posts are neatly japanned. It is being placed on the market by the Holtzer-Cabot Company, of Boston.

A New Mining Insulator and Clamping Ear.

The requirements of electrical appliances for use in mines have necessitated the production of a type varying considerably from those employed above ground, the conditions in the former case being much more severe than in the latter.

The insulator and ear shown in the accompanying illustration was designed for the use of the Thomson-Van Depoele Electric Mining Company, and is particularly suited to the purpose for which it was made.

The insulator body is of iron, thoroughly painted with graphite paint, to withstand the action of the sulphuric acid in the mines, the insulator itself being made of pieces of porcelain, rubber or other suitable material, strong and large to withstand severe strains. Its construction is such that the insulation is entirely protected from the blows of the trolley should it leave the trolley wire, and at the same time little opportunity occurs for grounding, as the head of the hanger bolt is imbedded in the porcelain or rubber, and the only joint in the insulation is filled by a soft rubber washer firmly forced into position when the trolley wire ear is screwed into place. The only opportunity for sur-

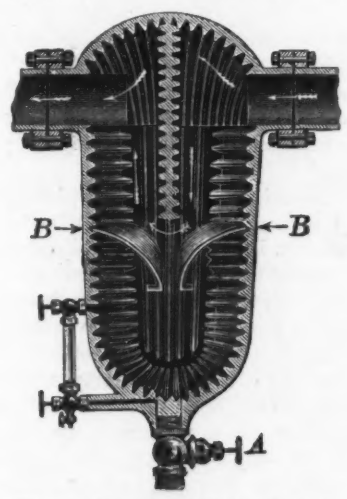


MINING INSULATOR.

face leakage is on the under side of the insulator along the surface of the cone, and as this has been corrugated the liability of leakage is reduced to a minimum.

An Improved Eliminator.

We give herewith a sectional view of a recent improvment made in the horizontal style of Hine's eliminator. It will be seen that a corrugated vertical diaphragm interposes between the inlet and the outlet sides, extending downward half the length of the body, which has been extended fully one-third its former length. Below this vertical diaphragm at the proper distance are two converging discs *B B*. The operation is as follows: The steam upon entering as indicated by the arrow courses is driven against this diaphragm, the corrugations upon which as well as those in the body run transverse to the current of the steam, by expansive impingement and its impulsive force is thoroughly broken up, effecting separation before turning into the outlet side. The water and other particles eliminated from the steam will pass on a direct line between the discs into the chamber below when they are away from the current and out at the drip valve *A*, while the clean dry steam passes under the diaphragm and upward, being deflected by an inward extend-



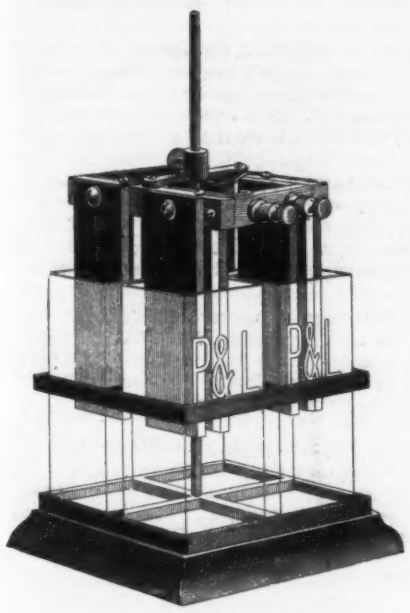
HINE'S IMPROVED ELIMINATOR.

ing pipe at the immediate point of outlet. The manufacturers claim that tests have demonstrated that these changes in the horizontal style make it fully the equal of the vertical style, which in the competitive test of steam separators made at Cornell University last year demonstrated in twelve different trials with steam under varying conditions the remarkable average of 98.7 per cent. dry steam. The Hine Eliminator Company, 106 Liberty street, New York, is the sole proprietor and manufacturer of these eliminators.

Electrical Forging.

We present herewith a cut showing the generating plant of the Electrical Forging Company, of Boston, the work of which has been attracting considerable attention of late. In fact, it has been loudly heralded, and stripping the facts of repertorial verbiage we find a process that is decidedly interesting. In principle there is no striking novelty involved; in practice the details of the apparatus have been worked out with great ingenuity. The process consists in the heating of blanks for forging, by passing an electric current through them and raising them to the requisite degree of heat. The idea is already familiar in electric welding, but the further extension of the principle to the heating of blanks, even while under the hammer, is of considerable importance. There is no particular difficulty in supplying the current, and it is found by experience that the iron and steel to be used of the requisite size can be heated to the point necessary for forging, and kept

at that heat, with fewer mechanical difficulties and greater economy than has been supposed possible. The metal too can be heated just to the temperature desired, and kept there until the process is finished. The heating is very much quicker than if it were accomplished in an ordinary furnace, and there is no necessity for reheating, the work being kept at the required temperature until finished. There is, too, a considerable economy of metal, for there is no scaling, as when made in the forge. Blanks can be cut very close to the finished weight. The process is especially adapted to the innumerable small drop forgings that are required in every day mechanical work. The amount of current required is not great in such cases, and the total labor is very much reduced. One of the interesting novelties is the machine for the manufacture of small balls, such as are used for ball bearings, by the electric forging process, diminishing their cost, and enabling a very rapid production of a good article.



NEW PLUNGE BATTERY.

The apparatus shown in the cut has no striking peculiarities, and resembles in a general way that employed for electrical welding, the same combinations of alternating current dynamo and the immensely massive transformer being used. The machinery by which forging is actually accomplished has been the result of a large amount of study, and has made possible this new application of electricity to an old branch of industry.

A New Form of Plunge Battery.

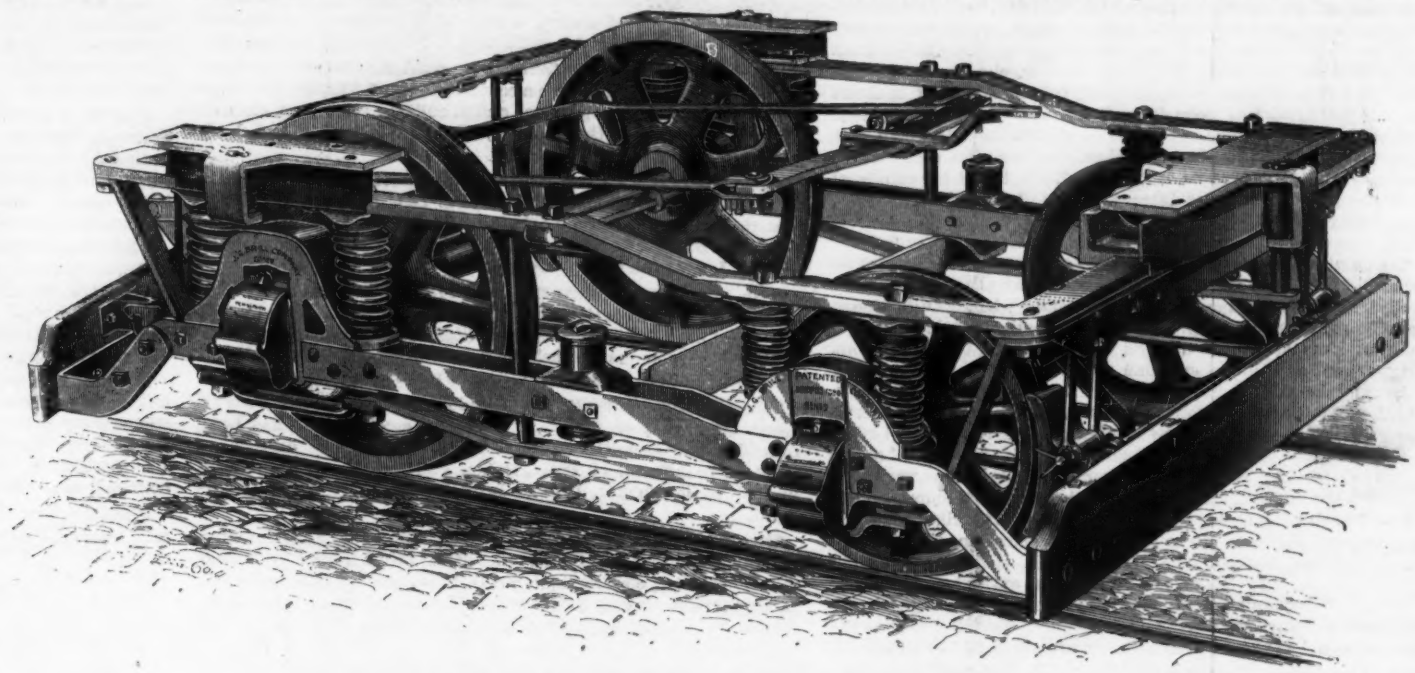
The illustration shows a new form of plunge battery, which is very compact and designed for use with either bichromate of potash, soda or chromic acid. This type of battery is adapted to all kinds of experimental laboratory and other special work, where it is not practical or economical to operate a dynamo. The internal resistance of this battery is only a very small fraction of an ohm and the voltage $1\frac{9}{10}$ volts per cell. It is so constructed that it is easily put in or out of action by lowering or raising the plates, which are held in place by a thumb screw as shown in the illustration. The rack is mounted on a black walnut base and the cells can easily be taken out for cleaning without the plates being taken apart. When in use an entire absence of any noxious odors or fumes is noted. The plates are easily adjusted, and can be renewed at any time at small expense. It is practically a new form of the "plunge" type and is designed and manufactured by Pfund & Lawton, dealers in electrical supplies, of 153 Broadway, Brooklyn, N. Y.

A Maximum Traction Pivotal Truck.

We show in the accompanying illustration a pivotal truck for electric propulsion, in which many new features are noted and with which it is stated a gain of $42\frac{1}{2}$ per cent. in traction is made.

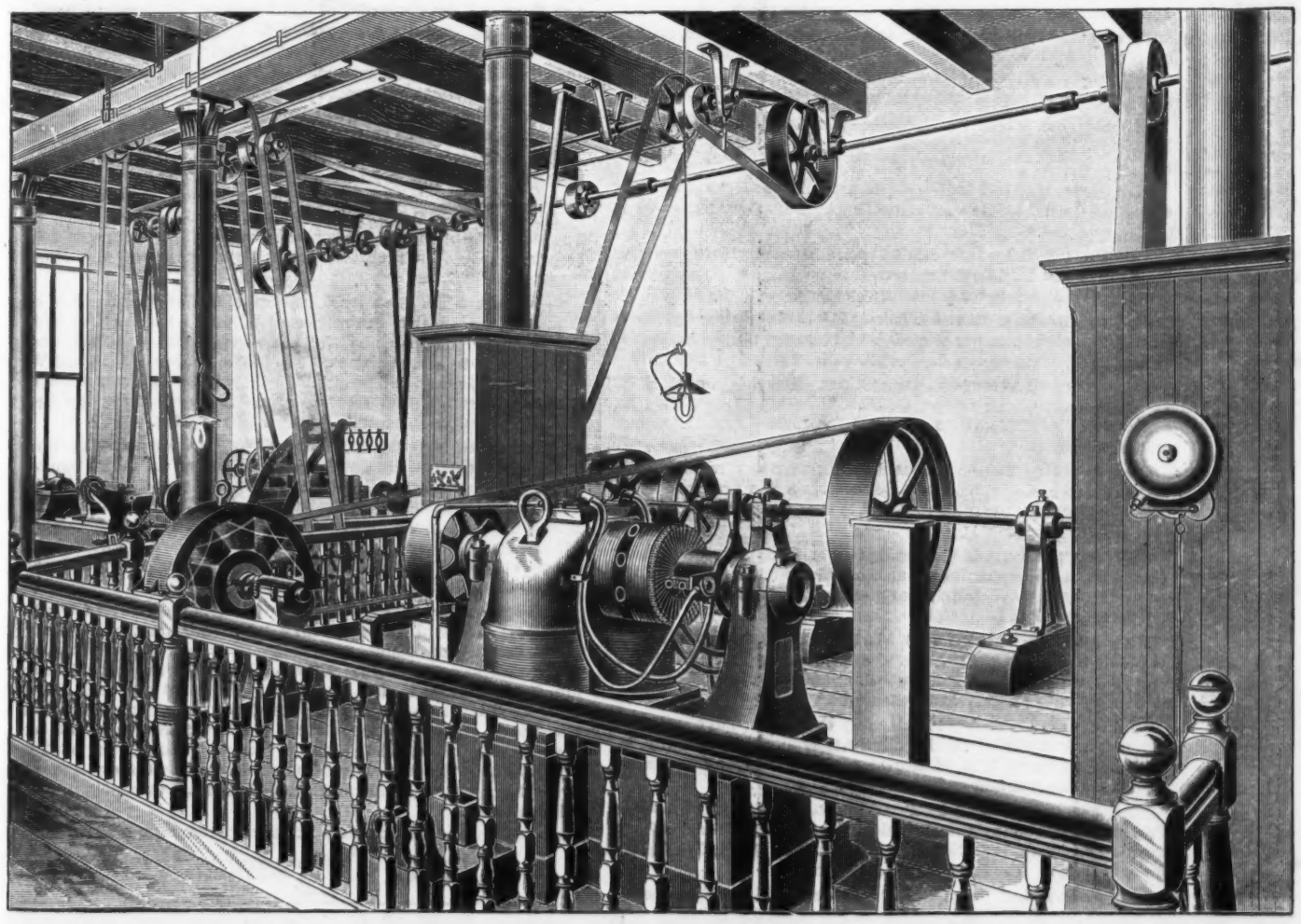
A reduction is also made in the height of the car body of 10 inches and thus the necessity for double steps is obviated. There is also shortening of the wheel base and the amount of power required is reduced by as high as even 30 per cent. The only objectionable feature, and not a serious one, was that the pivotal centre or drawing point which came over the axle was in the way in removing the motor and had to be taken off; which trouble was solved by use of the movable spider. It has no mechanical pivot and is specially adapted, it is claimed, for the "waterproof" and "ironclad" types of motors which have their upper portion hinged so that they can be raised when it is necessary to get at the armature or other parts of the motor.

The space above that occupied by the motor is free and clear, so that when the trap doors in the cars are raised the whole of the motor can be reached and the armature taken out without removing or disturbing any part of the truck. Also a further reduction of height of the car to the extent of one and a half inches is obtained, and the weight of the truck reduced by 150 pounds.



THE BRILL PIVOTAL ELECTRIC CAR TRUCK.

This truck has been brought out by the J. G. Brill Company, of Philadelphia, the pioneers in the business, who determined not to stop in improving until they had approached more nearly to perfection. This point they claim to have reached in the Brill Eureka maximum traction truck. It is stated that since their introduction several hundreds of them have been sold and are in operation.



VIEW OF THE ELECTRICAL FORGING COMPANY'S GENERATORS.

The whole work is very largely due to the ingenuity and enterprise of Mr. G. D. Burton, and his co-laborer, Mr. M. E. Angell, and during the last two years the Electrical Forging Company has grown to the dignity of a considerable industry. Considerable work has been accomplished, and many improvements have been and are now being made. Altogether electrical forging is a very practical and useful application of electricity, and one which is likely to become quite familiar in the future.

Novelties in Switches.

The illustration, Fig. 2, shows a switch which is intended to go into a panel or wall, and as will be seen from the cut, instead of protruding, as is usually the case, the handle or button is set in a recess so that the end comes flush with the wall. We also show in Fig. 1 an interior view of the improved construction of the 10-ampère Electrix switch. The handles have a large flattened metal nut in the interior, which makes it impossible to break or twist them off, while the wire connections are provided with a very convenient set screw. These switches are being placed on the market by the Star Electrix Company, of Philadelphia.

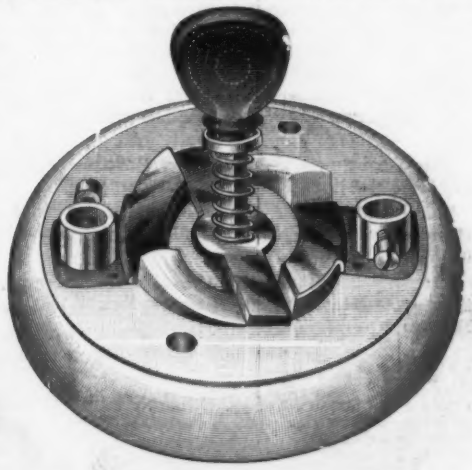


FIG. 1.—STAR ELECTRIX SWITCH.

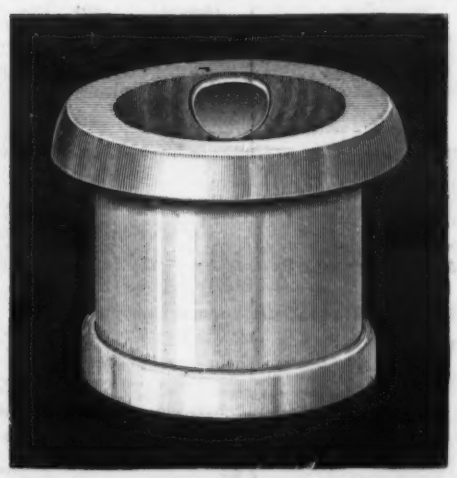


FIG. 2.—WALL SWITCH (OUTSIDE VIEW).

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

New York, Jan. 23, 1892.

The general stock market was quite spasmodic during the week. The various conditions have been almost as numerous as the days. The week opened with a lack of strength, and former prices could not be maintained. Up to Thursday all the principal stocks declined, and weakness was evident on all sides. The rumors of a Chilian war have done much to unsettle confidence, for if it became a reality the market would at once become demoralized; but during the last two days of the week a decided buoyancy returned to the street, and prices were strong again. The electrics have remained stronger than any other stocks on the market, mostly because there has been comparatively little trading in them. The United Electrical Securities Company has recently placed another issue of its bonds. A subscription for $1,000,000 worth was opened to investors, and in a very short time the total amount was oversubscribed to the extent of $200,000. These bonds are collateral bonds, bearing five per cent interest. Behind them there are held, as security, bonds of local electric light and power companies, which bear six, and in some cases, seven per cent. For each issue of the collateral bonds there is pledged as security an excess of 25 per cent. of the local companies' bonds, over and above the amount of the issue. This pledge renders the secondary bonds quite secure and offers to investors a new class of bonds, both profitable and safe. The first issue of this company's bonds was for $1,000,000, about one year ago; and since that time nearly $400,000 worth have been retired, by the sale of the bonds that were pledged as security. About $600,000 are therefore now outstanding. The recent issue was readily subscribed for by bankers, savings banks and other institutions, and also by private parties, mostly in Massachusetts and Rhode Island. Electric bonds were for a long time very slow to attract the investor's attention; but the plan of this company has seemed to solve the problem of how best to float this class of securities, which certainly deserve a good place in the market. The Industrial Improvement Company is another corporation which is indebted to the demand for and the extension of electric traction. This company has constructed new roads or purchased old horse railway property, and introduces electric power as the motive force. It has recently assumed control of all the street railways in Brockton, Mass., and equipped them with electrical apparatus. It owns also the Allentown & Bethlehem, Pa., electric road. The company is only about one year old, and, judging from the progress already made, it promises to be a valuable factor in the extension of electrical motive power on street railways. Its present capital is $500,000. The officers are: Hon. Oliver Ames, president; G. H. Campbell, vice-president, and A. A. Glasier, treasurer, all of Boston, Mass.

Increase in Capital Stock.—At the annual meeting of the Manchester (N. H.) Electric Light Company it was unanimously voted to increase the capital stock to a sum not exceeding $130,000.

The Salem Electric Lighting Company, of Salem, Mass., has voted to increase its capital stock $25,000.

The Worcester Electric Light Company, of Worcester, Mass., has voted to increase its capital stock from $200,000 to $250,000 and to issue $100,000 in bonds.

Street Railway Financial Notes.—It is estimated that the West End street railway will earn this year on the basis of $279,247 net for the first quarter, $1,497,000 net. The dividend requirements for the year will be $1,217,000, and the estimated surplus $280,000, or $190,000 more than for 1891.

A suburban electric railway in Reading, Pa., has made a rather remarkable showing in its report of business during four months of its operation. It was constructed without bonded indebtedness, is 5½ miles long, and for construction and equipment cost $124,581.63. The report states that it has earned money every day since it was opened and the earnings warrant a dividend of 2½ per cent.

The Lansing City Railway Company, of Lansing, Mich., has increased its capital from $50,000 to $100,000.

The Columbus (O.) Consolidated Street Railway Company has increased its capital stock from $1,000,000 to $1,250,000.

Closing Quotations.—The following were the closing quotations of electric stocks on Saturday, Jan. 23, 1891, in New York and Boston:

Name of Stock.	Par.	Capitalization.	Bid.	Ask'd.
Western Union Telegraph Co	100	86,200,000	83¼	83¾
American Telegraph & Cable	100	14,000,000	....	82
Central and South American	100	5,000,000	....	....
Mexican	100	2,000,000	....	....
Commercial Cable Co	100	7,716,000	....	....
Postal Telegraph Cable	100	5,000,000	28	33
Edison General Electric	100	15,000,000	90	92
Consolidated Electric Light	100	2,500,000	20	30
Edison Illuminating Co., of New York	100	4,500,000	80½	81½
" " " Brooklyn	100	750,000	72	75
" " " Boston	100	1,263,500	97½	102½
" " " Chicago	100	750,000	135	145
U. S. Illuminating Co	100	1,250,000	30	35
North American Phonograph Co	..	.....	2½	5
New York Phonograph Co	100	6,200,000	2½	5
Edison Elec. Light Co. (of Europe) stock	100	2,000,000	2½	5
" " " bonds	..	30,000	65	75
" Ore Milling Co	100	2,000,000	17½	22½
" Toy Phonograph Mfg. Co	10	1,000,000	....	½
U. S. Electric Light Co	100	1,500,000	15	20
Brush Illuminating Co., of New York	50	1,000,000	40	50
Mt. Morris Electric Light Co	..	500,000	....	60
East River Electric Light Co	100	1,000,000	....	60
Thomson-Houston Electric Co	25	6,000,000	51½	51⅝
" " preferred	25	4,000,000	26¼	26½
Thomson-Houston Electric Co.—Series C	..	40,000	8	8¼
Thomson-Houston Electric Co.—Series D	..	120,000	7	7¼
" International Electric Co	100	400,000	175	200
Thomson-Houston International Electric Co—Pfd	100	250,000	101	103
Thomson Electric Welding Co	100	1,000,000	40	55
" European Electric Welding Co	100	1,500,000	15	20
Westinghouse Electric Co	50	7,000,000	12⅝	13
Fort Wayne Electric Co	25	4,000,000	12¾	13
Fort Wayne Electric Co.—Series A	..	80,000	7	7¼
Detroit Electrical Works	10	1,000,000	8¼	8½
West End St. Ry. Co.—Com	50	7,150,000	73	73¼
West End St. Ry. Co.—Pfd	50	6,400,000	84½	84¾
American Bell Telephone	100	15,000,000	207½	208
Erie Tel. & Tel. Co	100	4,800,000	45½	46
Mexican Tel. Co	10	1,280,000	110	120
New Eng. Tel. & Tel. Co	100	10,304,000	50	51
Tropical Tel. Co	10	400,000	....	35c.

Chicago Quotations.—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on electrical stocks as follows:

TELEPHONE STOCKS.

Chicago	$224@ $226	Cumberland	$60@ $62
Central Union	55@ 57	Wisconsin	118@ 120
Michigan	81@ 83	Bell of Missouri	175@ 180
Great Southern	30@ 32	Missouri & Kansas	54@ 56
Colorado	34@ 36	Iowa Union	20@ 22
Rocky Mountain Bell	40@ 43		

ELECTRICAL STOCKS.

Chicago Arc Light and Power	$82@ $83	Chicago Edison Co	$140@$142

NEW INCORPORATIONS.

The Salem Electric Light and Artificial Ice Company, Limited, of Salem, Ind., capital stock, $15,000, has been incorporated to furnish light, heat and power by electricity. The organizers are C. C. Hauger, B. H. Cravens, and Lee E. Sinclair.

The Sanders Electric Light Company, of Portland, Ore., capital stock $200,000, has been incorporated to manufacture and sell lamps and machinery of all kinds. J. F. Sanders, E. W. Allen, H. G. Allen and E. P. Allen, all of Portland, are the incorporators.

The Illinois Electric Lamp Company, of Chicago, Ill., has been incorporated with a capital stock of $25,000, to manufacture and sell incandescent electric lamps and other electric appliances. J. F. Schaefer, O. M. Smith and Frank E. Baker are the organizers.

The People's Manufacturing and Investment Company, of Denver, Colo., with a capital stock of $100,000, has been formed to manufacture gas, etc., and is building water, gas, electric and smelting works. G. M. Allen, Henry W. Watson and J. J. Rofinst are the incorporators.

The Waterloo Cedar Falls Construction Company, of Waterloo, Ia., capital stock, $200,000, has been formed to build an electric railway between Waterloo and Cedar Falls, Ia. D. B. Lyons, G. S. Polk, W. F. Stotts and W. T. R. Humphrey, all of Des Moines, Ia., are the incorporators.

The Strohm Automatic Electric Safety Block System Company (incorporated in West Virginia), with its principal office in Philadelphia, Pa., has been organized with a capital stock of $5,000,000, to make and sell block and safety appliances. F. W. Sutterlen, John P. Mathieu and B. S. Wright are the promoters.

The Clinton County Electric Light, Heat and Power Company, of Lock Haven, Pa., capital stock $25,000, has been formed to supply light, heat and power by means of electricity. Chas. M. Blanchard, of Philadelphia, Pa., and Chas. M. O'Conner and W. B. Shoemaker, both of Lock Haven, Pa., are those interested.

The Amethyst Water Works and Electric Light Company, of Monta Vista, Col., capital stock, $100,000, has been formed to furnish water, electric light, etc. G. P. Wilson, Ed. E. Eversole, W. B. Mandeville, Eugene J. Renner, J. McArthur, Jno. Hecker, J. D. Maben, W. W. Reilly, G. W. Southery and Thos. Eversole are the incorporators.

The Logan Telephone, Water and Light Supply Company, of Logan, O., with a capital stock of $25,000, has been started to connect Athens, Logan, Columbus and intermediate towns by telephone; constructing and operating water-works and supplying light by electricity, etc. S. H. Bright, M. D. Moore, N. W. Hamblin, W. D Mansfield and Wm. P. Price are the promoters.

AFFAIRS OF THE COMPANIES.

The Boulder (Colo.) Electric Light Company has declared a semi-annual dividend of five per cent.

The Pittsburgh & Allegheny Traction Company has declared a quarterly dividend of 1¼ per cent.

The East Cleveland (O.) Railroad Company (Electric), has declared a quarterly dividend of 1½ per cent.

The annual meeting of the Thomson-Houston Electric company will be held in the early part of March.

The Edison Electric Illuminating Company, of Boston, has declared a dividend of 2 per cent. payable Feb. 1.

The Edison General Electric Company has declared its ninth quarterly dividend of 2 per cent. payable Feb. 1.

The Postal Telegraph Cable Company, of New York, will hold its annual meeting at the offices of the company Feb. 2.

The Edison General Electric Company, of New York, will hold its annual meeting Feb. 10 for the election of directors, etc.

The Edison Electric Illuminating Company, of New York, held its annual meeting on Jan. 26 for the election of directors.

The Consolidated Telegraph and Electrical Subway Company will hold its annual meeting on Feb. 19 for the election of directors, etc.

The United Electric Light and Power Company, of New York, will hold its annual meeting Feb. 5, for the election of trustees and directors for the ensuing year.

The St. Louis & East St. Louis Electric Railway Company at a recent meeting elected J. M. Bofinger, C. C. Carroll, J. J. Taussig, D. R. Powell and B. W. Fisher directors.

The Concord Street Railway Company, of Concord, N. H. at its annual meeting elected G. A. Cummings, H. A. Dodge, D. Richards, P. R. Holden, J. H. Albin, G. W. Abbott and G. B. Emmons as directors

The Westinghouse Electric Company directors have voted an interim dividend of 1 per cent. on the preferred stock of the company for the fractional part of the quarter ending Dec. 31, 1891, payable Feb. 1.

The Georgetown & Tennallytown Railway Company (Electric), at its recent annual meeting elected the following officers: President, S. Watkins; vice-president, J. E. Beall; secretary and treasurer, Geo. D. Ashton.

The East Cleveland (O.) Railroad Company (Electric) at its annual meeting elected A. Everett, president; C. W. Mason, vice president; H. A. Everett, secretary and treasurer; L. E. Beilstein, assistant secretary and treasurer.

The New Castle Street Rail way Company, of New Castle, Pa., at a recent annual meeting elected the following officers: T. W. Phillips, president; Wm. M. Brown, vice president and manager; S. S. Hamilton, secretary and treasurer.

The Suburban Rapid Transit Company, of Pittsburgh, Pa., at a recent annual meeting elected officers as follows: W. T. Cowan, president; T. A. Noble, C. E. Succop, H. Miller, R. Cunningham, directors. The lines are to be extended.

The Worcester Consolidated Street Railway Company, of Worcester, Mass., has petitioned the Railroad Commissioners for authority to increase its capital stock from $350,000 to $700,000 for the purpose of extensions to its electric system.

The Receiver of the North American Underground Telegraph and Electric Company, of New York, gives notice of a meeting of the creditors to be held at the office of Hildreth & Barker, No. 32 Nassau street, New York, on Feb. 15 at 2 P. M.

The Salem Electric Light Company, of Salem, Mass., at its annual meeting elected the following officers and directors: J. F. Almy, B. W. Currier, G. A. Gallup, J. P. Harris, Geo. M. Harris, and S. F. Smith, directors; clerk and treasurer, H. M. Batchelder.

The Boston & Montana Copper Company has issued a circular offering to each holder of 208 shares of stock the right to buy a $1,000 seven per cent. bond at 90 and interest, the subscription to apply on the building of an electrolytic plant at Great Falls, Montana.

The Charlestown Gas and Electric Company, of Charlestown, Mass., at its annual meeting elected the following officers: J. F. Hunnewell, president; Geo. B. Neal, clerk and treasurer; J. F. Hunnewell, L. B. Hathon, J. A. Sawtell, C. F. Byam, J. Turner, directors.

The Chesapeake and Potomac Telephone Company, of Washington, D. C., through its president and treasurer, Samuel M. Bryan, and Charles G. Bebe respectively, has announced that a dividend of 75 cents per share will be paid to the stockholders of that company on and after Jan. 25.

The North Hudson County Railway Company at a recent meeting of its directors in Hoboken, N. J., elected the following officers: S. B. Dod, president; H. Hillenc, vice-president; F. J. Mallory, secretary; W. Doubleday, assistant secretary; J. Mangels, treasurer; N. Goetz, superintendent.

The Metropolitan Street Railroad Company, of Atlanta, Ga., has been forced into a receivership by the Consolidated Street Railroad Company, which holds claims against it amounting to about $40,000, which are unsecured. The mortgage indebtedness of the company is $190,000, and unpaid verdicts in damage cases amount to $13,000.

The Manchester Electric Light Company, of Manchester, N. H., at its recent annual meeting elected the following directors: F. Dowst, J. W. Hildreth, H. E. Parker, J. B Varick, W. L. Elkins, Jr; J. C. Moore, J. A. Weston, A. Elliott, G. F. Lincoln. The report of W. G. Africa, the treasurer, was received and showed an increase in earnings.

The Mobile Street Railway Company, of Mobile, Ala., has had a petition for a foreclosure of a mortgage of $500,000, upon which one year's interest is due and remains unpaid, filed against it by the Fidelity Trust and Safety Vault Company, of Louisville, Ky. It is stated that several capitalists are ready to buy in the road and change it to an electric system.

The Crocker-Wheeler Electric Motor Company at its annual meeting elected the following officers and directors for the ensuing year: S. S. Wheeler, president; F. B. Crocker, vice-president and treasurer; D. H. Jeffery, secretary; R. N. Peterson, S. S. Wheeler, F. B. Crocker, David Crocker, A. F. Higgins, W. B. Baldwin and F. M. Jeffery, directors.

The Utica Belt Line Street Railroad Company, of Utica, N. Y., has elected the following officers and directors: William E. Baker, Winthrop Coffin, Boston; T. H Fearey, Syracuse; John W. Boyle, C. W. Mather, Charles B Tefft, W. W. Cole, Utica. President, W. E. Baker; vice-president, John W. Boyle; treasurer, Winthrop Coffin; secretary, G. E. Tripp.

The Butte Consolidated Street Railway Company, of Butte, Mont., at a recent annual meeting elected the following officers and directors: W. Bennett, president; Geo. P. Woolston, vice-president and general manager; W. H. Clark, treasurer; E. E. Congdon, secretary; directors, N. Bennett, W. Bennett, Geo. F. Woolston, E. E. Congdon and W. A. Clark.

The Missouri Electric Light and Power Company, of St. Louis, Mo., at a recent annual meeting elected the following officers and directors: S. M. Dodd, president; J. C. Richardson, vice-president; S. B. Pike, secretary and manager; J. C. Van Blascom, treasurer; directors, S. M. Dodd, J. C. Richardson, J. C. Van Blascom, J. W. Bell, E. Whittaker, T. H. West, R. C. Kerens.

The Utica Electric Light Company, of Utica, N. Y., has elected the following officers and directors: H. D. Pixley, T. Solomon Griffiths, M. J. Brayton, William E. Lewis, H. M. Scheuch, Utica; R. P. McDonald, Fort Wayne, Ind.; Joseph F. Blant, New York. President, H. D. Pixley; vice-presidents, R. B McDonald and William E. Lewis; secretary and treasurer, M. Jesse Brayton.

The Worcester (Mass.) Electric Light Company has increased its capital stock as noted elsewhere in this issue for the purpose, it is stated, of increasing its incandescent plant with a view to furnishing additional street lamps for the city. It is understood the present stockholders will be given an opportunity to subscribe to the new stock in the proportion of one new share to five old ones.

The Boulder Electric Light Company, of Boulder, Colo., at the recent meeting of its stockholders elected the following directors for the ensuing year: Dr. I. L. Bond, Geo. R. Williamson, B. M. Williamson, Col. J. H. Nicholson, and Dr. Reuel Bartlett The plant is to be enlarged this year by the addition of one and perhaps two boilers, and probably another large engine and two dynamos.

The Columbia Gas and Electric Light Company, of Columbia, S. C., which recently consolidated with the Columbia City Railway Company, has held a reorganization meeting and made J. T. Marshall, president; T. T. Moore, vice-president, and W. G. Childs, secretary. The consolidated company has succeeded in placing the issue of $100,000 of bonds, and is now making arrangements to complete its electric light and power plant.

The Oyster Bay, L. I., Electric Light Company has filed its annual report with the Secretary of State. It shows capital stock, $5,000, all of which has been paid up. The assets are $5,232.15, and consist of its electric lighting plant, and its franchises, easements, contracts, outstanding accounts, etc. The debts amount to $179.30, as follows: For power and labor furnished, $120; for legal services and disbursements, $59.30. The receipts during the year were nothing and the expenditures $59.25.

A Deed of Trust.—The Potomac Electric Company, of Washington, D. C., has placed on record a deed of trust to the Washington Loan and Trust Company, to secure to Joseph C. O'Gorman, or bearer, the payment of fifty $1,000 bonds issued on Jan. 15, bearing 20 years interest, first mortgage bonds, at 6 per cent. It is provided that these bonds may be taken up at any time after three years, in amounts not less than $3,000, and for a price not exceeding $1.05 for each dollar, and a sinking fund of 5 per cent. is provided for. The trust covers land in Alexandria County, and all the rights, franchises and grants in the District of Columbia, and all other persons.

Special Correspondence.

NEW YORK NOTES.

Office of The Electrical World,
167-177 Times Building, New York, Jan. 25, 1892.

The Metropolitan Electric Service Company has removed its office to 126 Liberty street, New York.

The Barriet Electric Company's stock, at 10 Cedar street, has been sold by the sheriff. Only $94 was realized. The company was incorporated in 1890 with a capital stock of $10,000, to manufacture electric motors.

Mr. Fred C. Timpson, formerly with the Empire City Electric Company, has opened a New York office for the Electrical Engineering and Supply Company, of Syracuse, N. Y., at No. 18

Cortlandt street, Telephone building. He reports that business is starting in well.

The Board of Underwriters of the city at a recent meeting considered the matter of the Edison Electric Lighting Company and electric lighting The unsafe equipments of a number of electric companies was also discussed, and it was said that a great many fires were due to unsafe wiring. It was proposed that a national conference between underwrting boards and electrical experts should be held.

Mr. and Mrs. F. V. Doty, whose marriage was mentioned in last week's issue of THE ELECTRICAL WORLD, are enjoying their wedding trip, which includes New York, Chicago and other points in the West. On Thursday of this week Mr. and Mrs. Doty were most agreeable callers at the office of THE ELECTRICAL WORLD. Mrs. Doty impresses one as a most charming lady, and she is to be congratulated on having secured as a husband a gentleman who is regarded as a representative business man and a thoroughly good fellow.

Mr. J. Stanford Brown, electrical engineer, who has offices in the Electrical Exchange building, reports business as rushing, so much so that he has been obliged to have a telephone placed in his office for the convenience of his patrons. The number is 1841 Cortlandt. At present he is of necessity compelled to be absent from his office considerably on account of the personal supervision which he is giving to the various contracts he has on hand. He is represented at his office at all times, however, or can now be reached by telephone.

National Electric Light Association.—The secretary of the association has sent out the following letter to central station non-members: "Great interest is being taken in the coming fifteenth convention of the association, to be held in Buffalo, N. Y., February 23d, 24th and 25th next. Knowing you to be interested in central station management, I take the liberty of calling your attention to the great benefits accruing from attending these meetings. The papers to be read at Buffalo are from men high in the science, and will treat on every valuable subject from "How to Fire a Steam Boiler" to "Electric Lighting from a Financial Standpoint," including the steam engine, dynamo, switchboards, overhead and underground wiring, motors, etc. We would be pleased to enroll you among our already large membership, and hope to welcome your representative at Buffalo." L. H. H.

PHILADELPHIA NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
927 CHESTNUT STREET, PHILADELPHIA, Jan. 23, 1892.

Dissolution of Partnership.—The firm of Clay, Pepper & Register, of Philadelphia, has been dissolved, and the business hereafter is to be carried on by the remaining partners under the firm name of Pepper & Register.

Mr. S. Ashton Hand, recently with the Equitable Engineering and Construction Company, of Philadelphia, is to take charge of the Detroit Electrical Works as superintendent. Mr. Hand has been connected with the Philadelphia company for several years, but on Jan. 1 the company went into liquidation and the members of the firm have been looking for employment elsewhere.

An Electric Club for Philadelphia.—A large number interested in the electrical field in Philadelphia have expressed themselves in favor of establishing an electrical club for this city, one that will be a credit to it. We wish to further their desire, and hope to see Philadelphia's electric fraternity take hold and establish a club on such a firm basis that its future success will be assured. Will all who would like to participate in the forwarding of this scheme please send their names to the "Electric Club," City Trust Building? If one hundred names are received, each party will be notified to attend a meeting at some hotel or other designated place. A large number have already responded and a few more names will insure a meeting for organization. W. R. W.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 28, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., Jan. 23, 1892.

The Hubbell Portable Electric Lamp and Power Company, of Boston, has moved its offices to 114 and 116 Bedford street.

The Eastern Electric Light and Storage Battery Company, of Lowell, Mass., has secured the contract for wiring the New City Hall and Memorial buildings at Lowell, and the work is progressing finely. It is also placing the mains in the new Public Library Building, Boston.

The Eddy Motor Company has established an office at 30 Oliver street, this city, which will be under the charge of Edwin R. Gilbert. This move was made imperative by the constantly increasing business of the company, and it is safe to say the office has been placed in competent hands.

The Telephone Employes' Mutual Benefit Association held their annual ball at Odd Fellows' Hall Thursday night, which was participated in by several hundred happy couples and was a complete success in every sense of the word. Music was furnished by the Germania Orchestra, which is saying that it was good.

Electric Light Plant Burned.—The Ferdinand street branch of the Boston Electric Light Company was destroyed by fire the morning of Jan. 23. The property destroyed consisted of 24 dynamos valued at $5,000 each; five 150-h. p. engines, one 100-h. p. engine, and one 300-h. p. engine. The estimated loss is $200,000, with insurance of $103,000.

Mr. Melville I. Brigham, formerly of M. S. Brigham & Co., owing to increase of business has formed a corporation under the name of the Brigham Electric Company, 65 Oliver street, where they make a business of construction work and supplies. Mr. Brigham's reputation has already been established and he is well known throughout New England.

The Schuyler Electric Company, of Middletown, Conn., which has the contracts for making the powerful search lights for the Navy, has increased its force by 75 new workmen, and is running the works till nine o'clock at night. This increased activity is caused chiefly by new orders from the United States government for search lights and electrical apparatus of various kinds.

For Cheaper Street Lighting.—Mayor Matthews is trying to reduce the cost of electric lighting in the city and believes that the city should own its own plant. City Engineer Jackson and Mr. B. S. Flanders for some time have been engaged in investigating the cost of such a plant. It is thought that the agitation will only result in another reduction in the cost of lighting by the present companies.

The Star Electric Company, of Bridgeport, Conn., is steadily increasing its business since moving into its new quarters. Contracts were closed this week for lighting the new freight depot and roundhouse of the Housatonic Railroad Company. A large incandescent plant has also been completed for the Bridgeport Wood Finishing Company and one for the Gross Bros., Lee, Mass., and Grey Bros., of the same place.

The Gloucester Electric Company formally opened its new building Tuesday evening by a public reception. There were about 150 present, including Mayor Andrews, prominent city officials, Collector Pew, a number of the clergy and almost every member of the City Council. There was also a large number of Salem and Lynn electric experts and capitalists, including Col. Cunningham, of Gov. Russell's staff; Hon. Francis Breed, of Lynn, and F. A. Ferguson, of Boston, president of the Gloucester Electric Street Railway. An elaborate spread was set in the gallery of the dynamo room.

Boston Local Electric Lighting Companies.—The principal figures of the annual reports of the two companies in Boston, the Boston Electric Light Company and the Edison Electric Illuminating Company have been sent out. Since the report of the former was prepared the capital has been further increased $181,800, making a total of $1,257,800. The company supplies between 500 and 600 customers, including the city of Boston. The last sale of the company's stock was in the auction at 104. A sale is very seldom made, as it is held closely, and principally in Hartford, Conn. The latter company has about 2,630 customers, the majority using incandescent lights, and a great many for power. The Edison General Electric Company owns about one-quarter of the stock, and the rest is held closely by private individuals.

The Thomson-Houston Company's exhibition at the World's Fair will be under the superintendence of Lieut. E. J. Spencer, at present at the head of the testing department in the works at Lynn. He will go to Chicago early in the summer with a corps of assistants, prepared to stay two years. The company will expend $500,000 in making the exhibit. The various associated companies scattered all over the country will combine in the display, taking up at least 20,000 square feet. Among the companies represented in the exhibition will be the Thomson-Houston Electric Company, Thomson-Houston Motor Company, Thomson-Van Depoele Mining Company Thomson Welding Company, Brush Electric Company, Fort Wayne Company, Short Company, International Company and the Bernstein Company. The company is to install a big lighting plant for the government at the Norfolk Navy Yard. The yards, shops and officers' quarters will be lighted. F. O. Blackwell has been put in charge of the company's mining works. G. M. Haskell, who has represented the company in San Salvador for a year, has returned. C. A. B.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 THE ROOKERY, CHICAGO, Jan. 23, 1892.

The Chicago Taxpayers' Association is sending out inquiries to mayors of cities asking several questions in regard to electric traction. Mayor Sullivan, of Indianopolis, has answered the same by stating that Indianapolis has the basis of one of the best electric systems in the world.

The Chicago Telephone Company has procured an injunction from Judge Tuley restraining the Board of Trustees of Rogers Park from interfering with the company putting up and operating telephone wires through the village. The trustees have threatened to prevent the stringing of wires on a claim that the company had violated the ordinance.

An Electric Road from Chicago to St. Louis.—The Chicago and St. Louis Electric Railroad Company, recently incorporated with a capital stock of $1,000,000, proposes to construct and operate an electric railroad from Chicago to St. Louis. The principal office will be in St. Louis. The incorporators and first board of directors are S. B. McBurney and A. H. Carper, of St. Louis; W. E. Beckwith, T. May, Jr., and E. C. Rhoades, of East St. Louis.

The Brush Company Sues the City.—The Brush Electric Company, of Cleveland, O., has brought suit in the United States Circuit Court against the city of Chicago, alleging that the arc electric lamps used by the city are infringements of the complainant's patents. Judge Lacombe, of the United States Court in New York, recently sustained the validity of the Brush patents, and all those now using the double carbon lamp without license or permission from the Brush Company will be proceeded against. The city is protected against damage from these suits, by the bond of the contractor who put in the plant.

The Edison Company Meeting.—The stockholders of the Chicago Edison Company held their meeting recently and unanimously elected the old Board of Directors. The names of the directors elected are as follows: A. F. Seeberger, John D. Drake, Lambert Tree, R. C. Clowry, E. I. Brewster, Byron L. Smith, Robert T. Lincoln, J. W. Doane, F. S. Gordon, A. A. Sprague, E. M. Phelps. The annual report of the company showed a surplus on hand of $243,000. The company was organized in 1887 with a capital of $500,000, which was increased in 1890 to $750,000, and during the year covered by the report a further increase of $250,000 was made and all taken by the stockholders at par. They have paid dividends at the rate of eight per cent. per annum on the capital stock beginning Feb 1, 1890, and aside from the plant situated on Adams street they have built a plant on Wabash avenue, between Twenty-sixth and Twenty-seventh streets, which was put in operation April 1. The business has considerably increased. They have connection at the Adams street station of 42,000 incandescent lights and of 1,242 horse-power and motors. The Wabash avenue station has 11,600 incandescent lights and 55 horse-power and motors. The company will make large additions to the plant this year. Negotiations are not yet completed for the real estate for the site of the new power house, but it is expected that the land will soon be purchased and the new central station started. F. DE L.

CANADIAN NOTES.

OTTAWA, Jan. 22, 1892.

Warmouth, N. S.—Mr. Freeman and Mr. R. H. Fraser are in town in the interests of the Edison Electric Company, and active operations are to be commenced toward putting in an electric street railway here.

Amherstburg, Ont.—The electric light engine which was ordered from Goldie & McCulloch, of Galt, has been received and David Herriot, of Galt, has been here the past week placing it in position. He expects to have it all set up and ready for use by the middle of next week.

Winnipeg.—Some hostility to the by-law granting the electric street railway franchise to Messrs. Ross & McKenzie, passed by the late Council, is manifesting itself. Judging by the recent developments, there seems to be a determination to upset the work of the last year's board.

The Hamilton Electric Light Company has just closed a contract with the Hawarth Belting Company, Toronto, for two large engine belts to be used in their new power station. Each belt is four feet wide, three ply thick and 115 feet long. When finished these will be the largest leather belts in use in the Dominion.

Victoria, B. C.—A complete electric plant has arrived from Toronto for Weller Bros., and is at once to be fitted up in their furniture factory, Humboldt street. The plant consists of a Ball dynamo, wound for a low tension circuit to carry fifty 16-c. p. incandescent lamps, a complete electrical outfit in the way of switch boards, rheostats, meters, etc. Power for the dynamo will be supplied by the main engine at the factory.

Ottawa, Ont.—The heating of No. 23 car of the electric railway, which was inaugurated last week, is giving every satisfaction and works admirably. The air in the car is soft and balmy and is a great improvement on the stove, which, no matter how well regulated, gives out more or less of a coal burning smell. The switch regulates the heat so that in a warm day less heat is distributed and on a cold day more. The temperature can be regulated at the will of the conductor of the car.

Vancouver, B. C.—Two companies will apply to the Legislature for incorporation with a view to building and operating other tramway lines between and within the cities of Vancouver and New Westminster. Electricity will be the motive power on both lines. The application notice of the one company is signed by Drake, Jackson & Helmcken, and the other by John Campbell. The latter company also proposes erecting and operating a telephone and telegraph system in each of the cities.

Hamilton, Ont.—W. Y. Sopher, of Ahearn & Sopher, who is interested in the Ottawa electric railway, has been interviewing the projectors of the Grimby railway. The promotors do not intend doing anything until the application for permission to use the streets is granted by the Board of Works and passed by the Council. On Dec. 22, 1893, the 20-year franchise of the Hamilton Street Railway Company will expire, and already the company has prepared a proposition to submit to the City Council for the renewal of the charter for 20 years more. No information is given at present as to the amount of mileage rental and percentage the company is prepared to give, but this will be stated in the communication to the Council. Mr. T. B. Griffith, secretary of the company, who has been studying the electric system in the chief cities of the States for a month, said that the system that they would use would be the trolley system, which he was convinced was the best available. The company is prepared to expend $250,000 on the system, if it acquires the renewal of the charter. F. L. J.

ENGLISH NOTES.

LONDON, Jan. 13, 1892.

Lighting of the City.—Owing doubtless to the irritation which has been aroused by the dilatory manner in which the lighting of the city has been carried out, there are now evidences in all directions that more energy is being put into the work. The narrow streets and lanes of the city are up in all directions. The conduits being used are either plain iron piping or Callender-Webber bitumen casing.

City & South London Railway.—The frequent and some what irritating alterations in the changes imposed by this company have not apparently adversely affected its traffic receipts, which reached their maximum, viz., £878, for the week ending Jan. 3. The figures for the corresponding week last year were £805. If the City & South London Railway maintains its weekly traffic receipts at anything like £878, the ordinary shareholders should soon be within sight of a dividend.

St. Pancras Vestry and Electric Lighting.—The St. Pancras Vestry, which, as I wrote to you a few weeks back, was reduced (owing to the refusal of the London County Council to advance it money) to the expediency of advertising for a temporary loan of £60,000, has a bill before Parliament authorizing it to borrow the sum of £36[illegible],000 for 42 years, to enable it if necessary to light the whole parish by electricity. There is a somewhat interesting clause in the bill authorizing the vestry to make use of the old tubes of the Pneumatic Dispatch Company as electric lighting conduits.

The Electric Light in Turkey.—A short time ago it was decided to light the new buildings of the Imperial Ottoman Bank at Constantinople by electricity. Tenders were invited from English firms and the contract was awarded to a well known bank lighting firm. The award had scarcely been announced, however, when the order was canceled by a telegram to the effect that the Sultan had refused to allow the work to proceed. It is rumored that the Sultan understood that the electricity was to be generated by "dynamite," and was therefore afraid of an explosion.

Obituary.—I have to record this week the sad and sudden death of Mr. F. R. Leyland, president of the National Telephone Company and vice-president of the Edison-Swan United Electric Light Company, which occurred on the Underground Railway on Monday evening. Mr. Leyland, although a man of considerable wealth and over 70 years of age, threw himself into the work of presiding over the multifarious business of the National Telephone Company with great energy and devotion. The death is also announced of Sir George Airy, ex-Astronomer Royal, who in his time did some important work in connection with terrestrial magnetism.

Elmore Copper.—The Elmore group of companies has recently announced the discovery of a very interesting if not very remunerative process. The Elmore method of making tubes is, as you doubtless know, to deposit copper on a revolving mandrel, the deposited copper being traversed by an agate burnisher. One of the Elmore companies is now turning out "planished" copper sheets by a modification of the old process. The tube as it grows is repeatedly exposed to the air and at each exposure a slight oxidization takes place sufficiently thin to allow further deposition, but thick enough to prevent adherence. The resulting tube is finally ripped up, flattened out and is sold as "planished" sheet.

Concentric Wiring.—I learn that the system of indoor wiring known as "concentric," which has been pushed in London by Mr. J. D. F. Andrews, and in the north by Messrs. Mavor & Coulson, is meeting with considerable favor. The systems employed by these two firms are somewhat different in detail, but generally speaking they consist of an inner stranded conductor and an outer sheathing of iron wire with insulation between. The fire insurance offices, for some occult reason, are opposed to concentric wiring, even in the case of isolated plants, but no doubt their prejudices will be overcome in time. In London, where some of our "three-wire" companies are pressing the Board of Trade to allow them to earth the middle wire, the concentric system with the outer wire well earthed would seem an excellent idea.

English Patent Office in 1891.—During the past year nearly 23,000 patents were applied for, being an increase on the previous year of over 1,500. The financial position of the Patent Office is exceedingly good. In 1890 there was a surplus of over £100,000, and the surplus for 1891 will certainly be larger still. After being worried by much agitation the government recently decided to devote a large portion of the accumulated surplus of the past three or four years to a wholesale reconstruction of the present incommodious

Patent Office buildings in Chancery Lane. It is now generally admitted that the Patent Office surplus income should be mainly devoted to schemes benefiting the patentee, and it may be expected that before long there will be some reduction in the Patent Office fees and an improvement in the various Patent Office publications.

Municipal Electric Lighting and Private Enterprise.—The recent action of the Glasgow corporation with regard to Messrs. Muir, Mavor & Coulson, who have for some years been running a couple of central stations in that city, is another instance of the scant consideration which private enterprise may anticipate at the hands of municipal electric lighting faddists. After lengthy negotiations, Messrs. Muir, Mavor & Coulson were informed they might expect *generous* treatment at the hands of the corporation with regard to the purchase of their system, now that the corporation was about to undertake the lighting of the city of Glasgow, and they were asked to state the sum they wanted. After this invitation the sum of £30,000 was mentioned, but the corporation valuers were of opinion that £14,000 was enough; finally £15,000 was accepted. No doubt this figure represents the value of plant and mains, and perhaps includes a trifle for good will, but it can hardly represent the value of the experience acquired by the working of this station in the early days of electric lighting, owing to which very experience the stations are now remunerative.

The Cost of Electric Lighting.—There is a lengthy discussion going on in the financial press with regard to the cost of electric lighting. It was started by a gentleman who complained of the excessive cost of electricity as supplied by the House to House Company on the alternate current transformer system. This letter gave Mr. R. E. Crompton an opportunity of scoring a point for the low pressure system and airing his favorite statement that what he calls the "sheer" cost of production is less in the case of electricity than in that of gas, and that the average electric lighting bill for large houses in the more important districts served by central station companies with which he is connected is about £25 per annum against £18 to £20 for gas. This statement by Mr. Crompton has called forth a challenge from the gas interest. A certain Mr. J. W. Stringfellow announces his readiness to set up a small gas plant (apparently on some patent system of his own) and to do a certain amount of lighting with gas, if Mr. Crompton wil follow suit with an electric plant. Trials of this kind seem to be a pet idea with the gas interest. Only a few days ago, in its review of 1891, one of the leading gas journals, the *Gas World* proposed as a means of settling once for all the question of relative cost and efficiency that Trafalgar Square and the Strand should be lighted in the best possible manner by gas and then in the best possible manner by electricity at the cost of the respective parties.

News of the Week.

THE TELEGRAPH.

A Government Telegraph Line.—The construction of a government telegraph line from Nanaimo, B. C., to Comox, 60 miles farther up the Vancouver Island coast, is to be commenced at once. The contract has been awarded to H. M. Claughlin, of Westminster, B. C., under the supervision of J. Wilson, government inspector of telegraphs.

For Underground Telegraph Wires.—Senator Carlisle has introduced a bill into the United States Senate authorizing the Spaulding Telegraph Company to construct lines of underground and submarine electric conductors from Washington, through Baltimore and Philadelphia, to New York and to arsenals and other military posts. The object of the bill is to provide more perfect telegraph facilities for repelling invasion and suppressing insurrection.

A Telegraph Contract.—The Great Northwestern Telegraph Company, of Montreal, which several years ago made a contract to operate the Montreal and Dominion Telegraph companies for 99 years, by paying an eight per cent dividend per annum, it is stated, is to hand over all its franchises to the Western Union Company, which will operate the two Canadian companies in the future. It is understood that the Great Nortwestern Company has been unable to pay the dividend of 8 per cent., in view of the opposition of the Canadian Pacific Telegraph Company.

Telegraph Message Contract Declared Illegal.—The Court of Appeals, Montreal, Canada, has given an opinion declaring illegal the contract which the Northwestern Telegraph Company prints on its blanks. The case on trial was the suit of L Lawrence for $200 damages for an error in the transmission of a message, by which he took an unnecessary trip from New York to Montreal. The court in the first instance awarded $30, the actual cost of the trip from New York, and the company appealed from this decision. The proof established the fact that the error was due to the negligence of the employés of the company, but the appellant set up the plea that the dispatches were sent under a contract, which declared that it would not be liable for damages resulting from errors unless the dispatch was repeated, and then only to the amount of 50 times the price paid for the message. Such a contract the court declared to be contrary to public policy, and any contract by which a party sought to fix the punishment for his faults was illegal, and the judgment was confirmed.

THE TELEPHONE.

The Wisconsin Telephone Company, of Racine, Wis., announces that the Racine system is to be thoroughly rebuilt and new office rooms leased. It is stated that $20,000 will be expended in new wires, poles, switchboards and other apparatus.

Bell Telephone Company.—Earnings for the year 1891, it is stated, were $3,128,000, or $259,000 more than for 1890. This is equivalent to 20.85 per cent. on the $15,000,000 capital stock, of which $12,500,000 received $18 per share in dividends, and $2,500,000 received $12, or a total of $2,550,000. This leaves a surplus of $578,000. The dividend recently paid was distributed among 35,000 stockholders.

THE ELECTRIC LIGHT.

Lisbon Falls, Me.—It is probable that an electric light plant will be established to be run by water power.

Colchester, Ill.—The new incandescent electric lighting system is completed. The streets are lighted with 35 and 50 c. p. lights.

Bedford, O.—The new plant of the Bedford Electric Light and Power Company is nearly completed, and will be in operation soon.

Hartford, Ky.—J. W. Ford and others are reported to be organizing a company with the view of establishing an electric light plant.

Paragould, Ark.—The work of erecting an electric light plant is going forward rapidly, under the supervision of Superintendent Overman.

Brenham, Texas.—Mr. Albert Smith, of New York City, is considering erecting and equipping an extensive ice and electric light plant.

Angola, Ind.—The city has made a new contract with the Angola Schuyler Electric Light Company. A new dynamo is to be added to the plant.

A new electric light company is to be organized at Hackettstown, N. J., it is stated, on account of dissatisfaction with the present company.

Chattanooga, Tenn.—At a recent meeting of the Chattanooga Electric Light and Power Company, it was decided to add a number of improvements to its plant.

Roanoke, Va.—The Roanoke Electric Light and Power Company has recently placed an order with the C. & C. Electric Motor Company, for an entirely new plant.

Seymour, Ind.—The contract for an electric light plant has been let to the Fort Wayne Electric Company. The plant is to be completed and in operation by March 1.

Youngstown, O.—The Youngstown Gas Company and the Youngstown Electric Company have united and will pool their interests, ending a long fight for supremacy.

Elyria, Col.—The board of trustees has passed an ordinance providing for the lighting of the town by electricity, and awarding the contract to the Denver Consolidated Electric Company.

The Beatrice Rapid Transit and Power Company, of Beatrice, Neb., has completed arrangements for an extensive electric light plant, which is to be in operation within thirty days.

Marion, Ind.—The electric light plant erected by the Fort Wayne Electric Company has been accepted by the city. The total cost of the plant was $23,415, to be paid by a series of bonds running 20 years.

Meridian, Miss.—A contract to light the city with electricity has been let to the Thomson-Houston Electric Light Company. The contract is for a period of five years at the rate of $15 per light of 1,200 c. p.

Wichita Falls, Tex.—The Wichita Falls Light and Power Company has obtained a franchise from the City Council for lighting the streets with electricity, and will establish a plant immediately.

New Electric Light Plant.—St. Ignace, Mich. has a new electric lighting plant, which was put in by Mr. James F. Moloney, of Cheboygan, Mich. The plant consists of 20 arc lights of 2,000 c. p., Sperry system.

Edgerton, Wis.—The Common Council at its recent meeting passed a resolution annulling the contract with the electric light company as the contract stipulated the lights should be in running order by Jan. 1.

Madison, Ga.—The Thomson-Houston Electric Company has recently finished an electric light plant. Mr. A. P. Rutherford, who has heretofore been connected with the Athens Gas Electric Light Company, is superintendent.

The Johnstown and Gloversville Gas Company, of Johnstown, N. Y., it is stated, has decided to discontinue furnishing incandescent electric lights on account of lack of support, after the first of February, and will offer its machinery for sale.

Alexandria, La.—A proposition has been made to the citizens by a representative of a syndicate of Philadelphia parties, looking to the erection and operation of an electric light plant in connection with a system of water-works. The negotiations are now pending.

Elizabeth City, N. C.—A movement is on foot looking to the organization of a stock company for the purpose of establishing an electric light plant. The representative of an Eastern company has proposed to furnish $4,000 of the required cost, if the citizens will subscribe $6,000.

Augusta, Ga.—An isolated incandescent electric light plant has been put into the Augusta brewery, by R. J. Edinfield, the Southern agent for the Wenstron Consolidated Motive Power Company, of Baltimore. The motor is of the Wenstron conjoint patent, and will run 160 lights of 16 c. p.

A large addition is being made by the Edison Light and Power Company, of Minneapolis, to its central station. A thousand horse power is being added to its boiler capacity and at present it is setting up a 250-h. p. Ball engine and has put in in addition to its dynamo capacity, two 100 kilowatt Edison generators.

Doylestown, Pa.—A committee consisting of Henry Lear, A. F. Scheetz, Dr. W. H. Kirk, John Yardley, James Pollock and Henry S. Murfit, representing the Doylestown Electric Company, has asked the privilege of presenting a proposition to City Council regarding the lighting of the streets with electricity.

The United Light Company, of Uniontown, Pa., has added to its central station one 500-light Westinghouse alternator, one 60-light arc alternator, and one 150-h. p. Westinghouse compound engine. It now has one 1,300-light and two 500-light Westinghouse alternating incandescent machines and two 60-light alternating arc light machines, and carries on the daylight circuit about 22 ampères and on the night circuit from 85 to 124 ampères.

New Lighting Contract.—The specifications for 700 electric lights of 2,000 c. p., suspended on mast arms, have been drawn up by the Board of Public Works of Indianapolis Ind., and bids will be asked for five and ten years, the contractor to furnish all necessary material and do all the work of whatever kind necessary to construct, equip and maintain in a good and substantial electric condition a first-class plant, complete and ready for operation for lighting the city, and when the same is completed shall operate the same in its entirety for a trial period of 60 days.

THE ELECTRIC RAILWAY.

Marlboro, Mass.—The extension of the electric railway line between this city and Westboro is being agitated.

Connellsville, Pa.—John L. Gans has organized a company, capitalized for $100,000, to build seven miles of electric road.

The Beatrice Rapid Transit and Power Company, of Beatrice, Neb., will at once extend its electric lines to all parts of the city.

Pittsburgh, Pa.—The directors of the West End Street Car line at a recent annual meeting decided to adopt electricity as a motive power.

A New Electric Street Railway has recently been completed at Phœbus, Va., and, it is stated, is being operated with the best of satisfaction. The line is three miles long.

Shelbyville, Ind.—The City Council has granted a 50-year franchise to the Shelbyville Electric Street Railway Company to construct and operate an electric railway.

The St. Louis & Kirkwood Rapid Transit Company, of St. Louis, Mo., contemplates starting work at once on its proposed electric line from the limits of the city to Kirkwood.

West Chester, Pa.—The survey for the new electric railroad from Lenape to Unionville, a distance of five miles, will be made soon, as it is stated that the necessary money has been subscribed.

Lawrence, Mass.—The Merrimack Valley Street Railway Company, it is understood, has decided to introduce the Thomson-Houston system on all its lines, and work will be commenced at once.

San Francisco, Cal.—The San Francisco & San Mateo Electric Railway Company has made arrangements for transfers with other lines. It is expected that the road will be in operation early in March.

For Trolley on Franklin Avenue.—A bill has been introduced into the Legislature by Assemblyman Kelly for the use of the trolley on certain parts of Franklin avenue, Brooklyn, near Prospect Park.

Racine, Wis.—The City Council has granted the Belle City Street Railway Company a franchise for laying seven miles of additional track. The estimated cost of eqiupping the road electrically is $200,000.

The Telegraph Avenue Electric Railway, of San Francisco, Cal., the city attorney has decided, has the right to substitute electricity for horse power and that a new franchise is unnecessary. It is stated that the change will be made at once.

The Tonawanda Electric Street Railway Company, of Tonawanda, N. Y., which recently completed its lines from Buffalo, is desirous of extending its system through to Niagara Falls and is trying to secure consent of the Council for a franchise.

From Cable to Electric.—Some very important changes will be made in the rapid transit system of Denver, Colo. The Denver Tramway Company has decided to abandon its cable system and replace it by electricity. The lines will also be extended.

Waltham, Mass.—A stock company is being organized, it is stated, with a capital stock of $50,000, by F. Buttrick, of Waltham, and S. S. Gleason, of Watertown, Mass., to construct and operate an electric street railway between Waltham and Watertown.

The North Hudson County Railway Company, at a recent meeting of its board of directors in Hoboken, N. J., decided to adopt the trolley system on its surface road from the Hoboken boundaries to Union Hill, and to place a modified trolley plant on the Central avenue elevated road.

Kansas City, Kan.—Work has been commenced on the Thayer-Enright Electric Street Railway, the franchise for which was passed by the City Council. It will be six miles long, equipped with the best of material, and it is estimated more than $300,000 will be spent in material and labor.

Street railway prospects in Alexandria, Va., it is stated, are more auspicious. The Alexandria & Fairfax Passenger Railroad Company contemplates constructing an electric railway in Alexandria and has asked for the granting of an extension of the time for commencement of work for 90 days. An ordinance was passed recently by the City Council granting the request.

Harrisburg, Pa.—A charter has been granted to the Citizens Passenger Railway Company to run an electric line from Oberlin, to Harrisburg, a distance of six miles. The new corporation has a capital stock of $100,000, divided into 2,000 shares of $50 each. J. A. Dunkle has been elected president. Work will be begun at once, and it is expected that the road will be in operation early in the spring.

Trolley Poles Erected in Brooklyn.—Mr. William Richardson, president of the Atlantic Avenue Railroad Company, of Brooklyn, has taken the initiative step in the trolley controversy. He has caused a number of poles to be erected in front of the property owned by his company in Atlantic avenue. The poles were set in the sidewalk, within a few inches of the curb. They are of iron, and much taller than the electric light poles, but much smaller in diameter and painted yellow.

The entire plant of the Uniontown (Pa.) Electric Street Railway was burned recently. It had been in very successful operation for the past ten months and consisted of a 100-h. p. Ball engine, one 80-h. p. Edison generator and three cars fitted with two 15-h. p. Edison motors each. The company has commenced to rebuild and will install two 135-h. p. Edison generators, three 100-h. p. boilers, two 150-b. p. engines (make not settled on) and six cars (30-foot) with two 15-h. p. motors each. This company now owns something over three miles of track and will extend during the coming summer.

An interesting street railway construction race is in progress in Sioux City, Ia., between three companies that are building electric lines from the city to Leeds, a suburb five miles out. Two companies had been granted franchises, and the third recently rushed a long forgotten ordinance through the City Council at a midnight meeting and then put 36 teams at work hauling rails and 150 men to lay them on disputed streets. At daylight the streets were covered with the rails of the companies of duplicate franchises and the new company was in the lead. It has been organized by Eastern capitalists and is in the field to stay.

Brooklyn's Trolley System.—Mayor Boody of Brooklyn allowed the second trolley resolution passed by the Board of Aldermen to become a law at noon Jan. 23. The ten days allowed him within which to sign or veto the resolution expired and the Mayor allowed it to pass without his signature. The resolutions permit the Brooklyn City Railroad Company, Atlantic Avenue Company, DeKalb Avenue Company and the Brooklyn & Newtown Company to change their motive power from horses to the trolley system. Work must be commenced before May 1. The consent of the State Railroad Commissioners is still required before the companies may begin operations. The Brooklyn City Railroad already has a power house which operates a road running on Second avenue from Thirty-ninth street to Bensonhurst. It will take at least two years before the other companies can get their roads in operation.

Trolleys are Best.—Mr. Herman Bergholtz, of Scranton, Pa., was in Grand Rapids, Mich., recently, and the Grand Rapids *Democrat* had the following in regard to his inspection of the electric street railway lines in that city: "In company with Manager Chapman of the Consolidated street railway, of this city, Mr. Bergholtz examined the facilities and methods of the local company and was afterward profuse in expressions of commendation upon its perfection. 'I hail from a town of exactly the same size as Grand Rapids,' he said to a reporter for the *Democrat*, 'and it is the centre of vast electrical interests, too, but we have no such system of street railways as I find here. I doubt if any city in the Union can boast a superior system. The power plant and rolling stock are of the best known to electric railroading. I have examined the mechanism of the engines and line shaft at the Lyon street station, and I am truly surprised at the amount of intricate and expensive machinery employed by the company. I am tempted to use very strong terms in praise of the man who selected or designed that plant.' Asked what progress was being made in electric motors designed to do away with the overhead system of trolley wires, Mr. Bergholtz said: 'Of more than 300 cities now making use of the electric system

of street railways, there are not a dozen that do not use some modification of the system which this city has adopted. The best among them are using the overhead trolley system. For the most part all other systems are rapidly giving way before it. I do not think, from recent developments, that five years hence will find any considerable change in this system. It is elastic, economical and reliable. What more can be asked for?"

What is said of the trolley by the mayors of cities and others, where the trolley system is in use, can be seen from the following answers which were received by Mayor Boody, of Brooklyn, to the following inquiries: 1. What is the general public feeling with reference to the operation of the cars by the trolley system? 2. Have accidents occurred to man or beast since its introduction attributable to the trolley? 3. Have the results of its use been satisfactory thus far? 4. How long has it been in use in your city? 5. Have the views which you may have entertained when the substitution of trolley for horse power was proposed changed? 6. Will you please make any suggestions which may occur to you as a result of your experience? Mayor Manning, of Albany, writes that the trolley system has proved successful there; that the only accidents from its use have been from carelessness or interference with the telephone wires and that the use of the trolley is a great advance over horses. Mayor Fifield, of Lowell, Mass., writes that the public feeling in his city is favorable to the trolley, from the use of which there have been no accidents reported. He says that the trolley has been in use about three years in Lowell, and that he has a better opinion of it now than when it was introduced. Mayor Gourley, of Pittsburgh, reports that the trolley is much better than the old horse car mode, and that no human lives have been sacrificed by its use. He expresses his good opinion of the motive power, which he says has, up to the present time, proved more feasible than the underground system for electric traction. Mayor Boody also received a letter from Elias Lewis, Jr., of Brooklyn, presenting him with information from private letters he (Mr. Lewis) has received concerning the trolley service in Lincoln, the capital of Nebraska, a city with 37½ miles of street railroad moved by the trolley system of propulsion. The city has nearly 60,000 population. The president of the First National Bank of that city writes to Mr. Lewis: "The electric road has no opposition whatever. People are highly pleased with the change from horse power to electric. There are no serious objections to the overhead trolley system. No more objection to street railway wires than there is to the wires of the electric light, telegraph and telephone poles." The president of the Electric Railway Company in that city writes to Mr. Lewis in a similar vein. He says: "The overhead wires are not considered unsightly or dangerous." Wm. G. Rose, Mayor of Cleveland, in reply to the questions says: "The public are satisfied that the electric trolley system is a vast improvement over horse cars, being more rapid, cleanly, and affording greater facilities for moving large crowds." Mayor Clarke, of Erie, Pa., writes: "Our people are pleased with the working of the system." The Mayor of Columbus, O., replied to the questions as follows: "The trolley system has been very satisfactory. It has been in use four months. We would not exchange the new system for the old horse cars."

LEGAL NOTES.

In the case of the Consolidated Electric Light Company against the McKeesport (Pa.) Light Company in a litigation in the United States Circuit Court, a decree has been issued by Judge Acheson sustaining the exceptions taken by the defendants for a bill for printing amounting to $2,329.92.

An Interesting Decision.—A decision valuable as a precedent in street railway cases was recently decided by Judge Hart of the District Court at Duluth, Minn. He decided that the Duluth Street Railway Company has, under the right of eminent domain, authority to condemn private property for street railway purposes. It is stated that this is the first case of the kind involving this question which has ever come up in Minnesota.

Suit Withdrawn.—It is understood that Frank J. Sprague, has withdrawn his suit against Charles W. Gould, assignee of Field, Lindley, Wiechers & Co., to restrain him from disposing of stock in the Edison General Electric Company, which Mr. Sprague had deposited with the firm as collateral for a loan. After the suit was instituted it was ascertained that the stock had already been transferred. Mr. Sprague will now, it is stated, take his chances as a general creditor. The criminal proceedings begun by Mr. Sprague against Edward M. Field will continue. The books of Field, Lindley, Wiechers & Co. will be returned by the District Attorney to the assignee, who is making up a statement of the assets and liabilities.

In the matter of the application of the directors of Stanley & Hall, of New York, a corporation, for voluntary dissolution, Thomas F. Stevenson, receiver, gives notice of his appointment and qualification as such, and of the following: "First. All persons indebted to said corporation to render an account to me, at my office, No. 95 Liberty street, in said City of New York, by the 10th day of March, 1892, of all debts and sums of money owing by them respectively, and to pay the same to me. Second. All persons having in their possession any property or effects of said corporation to deliver the same to me by the said 10th day of March, 1892. Third. All the creditors of said corporation to deliver to me their respective accounts and demands by the said 10th day of March, 1892. Fourth. Any person holding any open or subsisting contract of said corporation to present the same in writing and in detail to me, at the place aforesaid, on or before the said 10th day of March, 1892."

PERSONALS.

Prof. Alexander Graham Bell has left Washington, D. C., for a trip to Europe.

Mr. Francis G. Daniell, formerly with the Short Electric Railway Company, of Cleveland, O., is now with Barry & McTighe, of 52 William street, New York.

Mr. L. T. Mason, formerly superintendent of an electric light station in Buffalo, N. Y., is to remove to Atlantic City, where he will have charge of the electric lighting plant.

Mr. F. W. Cushing, formerly electrician of the Postal Telegraph Company, and lately with the Central Electric Company, of Chicago, has been appointed Western agent for Day's Kerite wires and other specialties, with headquarters in Chicago.

Mr. E. E. Chaflin, of the Franklin Electric Company, Kansas City, is making an eastern trip, taking in Boston, Providence and New York. He has secured for his company the general agency for the Consolidated Electric Manufacturing Company of Boston.

President Thomas Lowry, of the Twin City Street Railway Company, of Minneapolis, was given a banquet recently by the business men of Minneapolis and St. Paul. It was an enthusiastic gathering of representative citizens of the two cities in honor of a gentleman who has done so much to build up and join the Twin cities by the finest street railway system in the world.

Mr. M. J. Francisco, president of the Rutland Electric Light Company, of Rutland, Vt., recently installed an Edison electric lighting plant of 250 lights in the Congregational church of the city. Referring to the plant, the Rutland *News* recently had the following: "The entire plan of lighting was designed by M. J. Francisco, president of the Rutland Electric Light Company. The many new features introduced are of his planning, and give evidence of his skill as an electrician."

MISCELLANEOUS NOTES

The Robison Electric Street Railway Company of Toledo, O., by a recent fire lost its car barn and 35 electric motor cars. The estimated loss was about $150,000.

The new electric pump at the Virginius mine, near Helena, Mont., it is stated, is now working at the 1,300-foot level, and is giving perfect satisfaction, with an immense saving of expense for fuel on account of the electric power.

Baltimore, Md.—The Baltimore Traction Company is transforming a church building it has purchased into a power plant, which, exclusive of machinery, will cost $15,000 when completed, which will be about the latter part of March.

The Pittsburgh Electric Club.—President Morris W. Mead, of the Pittsburgh Electric Club, has appointed the following committees for the government of the club: House committee: N. H. Byam, chairman; H. F. Albright and F. H. Ketchum. Entertainment committee: E. H. Heinrichs, chairman; W. McC. Ramsey and E. B. Thompson. Membership committee: John Campbell, chairman; D. W. Dunn and H. McL. Harding. At a recent meeting of the board of directors, Mr. Ernest H. Heinrichs, of the Westinghouse Electric and Manufacturing Company, was elected librarian and historian.

Our esteemed contemporary L'Electricien added a number of contributing editors to its staff January 1, and hereafter will be edited by the following gentlemen: Prof. Monnier, of the Central School of Arts and Manufactures of Paris; Mr. Eric Gérard, Director of the Electrical Institute of Montefiore; Mr. Félix Lucas, Chief Engineer of the Engineering Department of Paris and Director of the State Railroads; Emile Dieudonné, Eugéne Meylan and J. A. Montpellier, electrical engineers. Some of these gentlemen have been for some time among the editing staff of *La Lumière*. Mr. Montpellier was the founder of the journal *La Revue Internationale del Electricite*, which journal, it will be remembered, was combined with *L'Electricien* some time ago, both being now issued together under the latter title.

The Middletown Electrical Society, of Middletown, Conn., at its last meeting elected the following officers for the ensuing six months: Max Loewenthal, president; A J. Ralph, vice-president; J. W. Garside, recording secretary; D. O'Donovan, corresponding secretary; J. C. Sanders, treasurer; F. H. Watson, editor, and A. J. Ralph, J. C. Sanders and W. S. Case, executive committee. All officers, with the exception of the vice-president and executive committee, were re-elected. A constitution was also adopted in an amended form and a standard text book for this organization was chosen. The reports of the various officers for the past term were very encouraging and the society promises to be a very beneficial one to all who are interested in the science of electricity. All the communications respecting membership or otherwise should be addressed to D. O'Donovan, corresponding secretary, care Schuyler Electrical Company, Middletown, Conn.

Industrial and Trade Notes.

The Edison General Electric Company has removed its offices in St. Louis from the Turner Building to more commodious quarters at 723 Locust street.

Mr. H. C. Madden, sales agent for the New Haven Insulated Wire Company, of 18 Cortlandt street, New York, has just closed a sale of $20,000 worth of copper wire, for his company.

The Heisler Electric Company recently installed a plant for the corporation of West Toronto Junction, Canada, and received the following telegram, which speaks for itself: "We congratulate you. Lights splendid, and, in general, all pleased. Editor of *Reporter*."

The John E. Beggs Machinery and Supply Company, of 74 Cortlandt street, New York, are paying special attention to electric mining, especially in connection with water power, and state that they have several important contracts on hand for equipment in that line.

I. P. Frink, of 551 Pearl street, New York, manufacturer of reflectors for electric lighting, recently received the following letter from Columbus, O.: "The lighting of the Senate and House Assembly rooms by electricity is giving excellent satisfaction and the reflectors furnished by you are much admired."

The American Electrical Works, of Providence, R. I., is sending out souvenir photographs of the National Electric Light Association Convention which was held at Montreal in September of last year. It shows many familiar faces and will be treasured by many as a reminiscence of one of the most enjoyable meetings of the National Association.

The New Process Rawhide Company, of Syracuse, N. Y., at its recent annual meeting elected the following officers and trustees: T. W. Meachem, president; Wm. B. Kirk, vice-president; A. C. Vosburgh, secretary; J. C. Kenyon, treasurer. Trustees, T. W. Meachem, W. B. Kirk, E. Laass, J. C. Kenyon, J. Amos, C. L. Stone and A. C. Vosburgh.

The Ries Electric Specialty Company, of Baltimore, Md., Elias E. Ries, president, was awarded the first premium and medal at the electrical exposition, recently held at Augusta, Ga., for its regulating socket for alternating current incandescent lamps. This company is deserving of this honor. The Ries regulating socket is being generally adopted throughout this country and abroad, and it is stated is giving the best of satisfaction.

Mr. Otis K. Stuart, of Philadelphia, reports that he is receiving many inquiries about his Freeman transformers. He states that the "removable plug," on which the fuses are arranged, is a feature which central station men like. The plugs can be kept all ready wired in the station, and when a transformer fuse "blows" a fresh plug can be put in, and all danger to linemen is avoided. This is a very convenient feature in the dark or in cold and wet weather.

"Notes on Power Plants" for electric railways and electric lighting is the caption of an illustrated pamphlet of 31 pages, which is being distributed by Westinghouse, Church, Kerr & Co. The "notes" are preliminary, and will be followed by a more careful digest within a few months which will bear more fully on the details of power plants. The pamphlet noted above, however, is replete with much valuable information and is worthy the consideration of the reader.

The Electric Appliance Company reports that although it is very early in the season there is a demand for swinging ball lightning arresters and requests for information in regard to the same are being received, promising a big business in them when the season gets further advanced. The swinging ball lightning arrester has had a test of nearly three years' practical service in stations in nearly every part of the United States, and, it is stated, has never been charged with a single failure to do its work.

Queen & Co., of Philadelphia, some time since placed on the market a new type of electrodynamometer which, it is stated has met with great favor. By the adoption of an agate bearing instead of fibre suspension as formerly used, the element of torsion is eliminated, and greater accuracy obtained in consequence. These instruments are extensively employed as absolute standards in measuring both direct and alternating currents, and are adapted for use in central stations as checks for commercial ammeters.

The Hine Eliminator Company, of 106 Liberty street, New York, reports sales of eliminators during the past week as follows: Gordon Steam Pump Company, Hamilton, O.; E. C. Atkins & Co., Indianapolis, Ind.; Austin Water, Light and Power Company, Austin, Tex.; Commercial Milling Company, Detroit, Mich.; Clark Bros., Belmont, N. Y.; F. Schenk & Sons (second order), Wheeling, W. Va. In a letter from W. A. Foote, manager of the Battle Creek, Mich., Electric Light Company, to the Hine Eliminator Company, he says: "We would not again set up an engine without an eliminator."

The Electric Construction and Supply Company, of 18 Cortlandt street, New York, has one of its new search lights on exhibition at its offices. This search light is about 4,000 c. p.; it is portable and easy of manipulation, very simple in construction, and is finished in brass. Having no iron about it except the core of the magnet, the lamp works automatically, holding the focus and requiring no adjustment after once being set. The company has now in use some six sizes, ranging from 2,000 c. p. up. As this light is in practical operation all interested who have not seen a search light working can do so by visiting the above company's offices.

The Electric Appliance Company, it is said, is meeting with very gratifying success in the introduction of its latest specialty, the Standard lamp. To remove any erroneous impression that may be abroad the company desires to state that this is a new lamp and manufactured by an entirely new company, having in its employ some of the most experienced lamp men in the country. Great claims for life, efficiency and non-discoloration are made and are being substantiated on every side by those who have tested and adopted the lamp. The Electric Appliance Company also reports large sales of Paranite wire and its hearty recommendation by all users.

The Berlin Iron Bridge Company, of East Berlin, Conn., is just completing a new machine shop for the Bridgeport Machine Tool Company, at Bridgeport, Conn. The building is made entirely of brick and iron, divided into two parts, each 40 feet wide—the total length being 96 feet. One portion is two stories high, the roof and floor being designed for light work; while the opposite half of the building is of the same height, but the second floor is omitted so that it may be used as an erecting shop. The erecting shop is controlled by a traveling crane. The building when completed, it is stated, will be one of the most perfect and best designed machine shops in the New England States.

H. Ward Leonard & Co., electrical engineers, Electrical Exchange Building, New York, report that they are at present installing the following plants: Mail and Express Building, Catherina Bradley Building, Geraldine Building, Germania Fire Insurance Building, Du Vivier & Co. Building, F. O. Du Lous Building, Fifth Avenue Theater, Graham Hotel, John H. Inman's residence, all in New York. Franklin Trust Building and Columbia Theater, Brooklyn. They are also consulting engineers for the following firms: Otis Elevator Company and Ingersoll-Sergeant Drill Company, of New York; Wm. Sellers & Co., Philadelphia; Eastern Electric Company, Limited, St. Johns, N. B.; Providence Journal Company, Providence, R. I.; Middletown Music Hall, Middletown, Conn.; Rock Hill Electric Company, Rock Hill, S. C.

The Stirling Company, manufacturers of water tube safety boilers, J. Bradford Sargent, agent, 620 Atlantic avenue, Boston, has recently closed the following contracts for Water Tube Safety boilers: Carnegie, Phipps & Co., Pittsburgh, Pa., 1,200 h. p.; San Francisco & San Mateo Ry. Company, San Francisco, Cal., 1,250 h. p.; Los Angeles Con. Elect. Company, 1,500 h. p.; Pacific Rolling Mills Company, San Francisco, Cal., 1,500 h. p.; Braddock Wire Company, Braddock, Pa., 600 h p.; Cincinnati Water Works, Cincinnati, Ohio, 1,200 h. p.; Cold Storage Company, Chicago, 1,800 h. p.; Minneapolis Street Ry. Company, Minneapolis, Minn., 2,000 h. p., second order; Toledo Water Works, Toledo, Ohio, 1,500 h. p. These orders were given, it is stated, after the closest investigation by the mechanical engineers of the various plants, after they had sent experts around the country to examine the Stirling boiler in actual operation, and were given in competition. The company has sold over 100,000 h. p. in the last three years, all of which, it is stated, are giving excellent results and perfect satisfaction.

The Knapp Electric and Novelty Company, of 34 Warren street, New York, are the manufacturers of an electric automatic instructor, which is said to be one of the most ingenious, instructive, and interesting electrical toys devised recently. It is like the slanting top of a school desk, with a bell where the ink well would be. It has 72 small brass pins, over which is placed a sheet of cardboard marked off into 72 squares, the squares having holes to fit the pins. In the 36 squares on the left hand side are 36 questions, and in the squares on the other side are the 36 answers to the questions. Two flexible wire cords, terminating in wooden handles with copper pointers, are attached to the desk, one on each side. The pointer on the left is placed on the pin in a question square, and connections are so arranged under the desk, as in a telegraph or telephone switchboard, that when the other pointer touches the pin over the answer to the question the bell rings, but it rings only when the correct answer is found. A great variety of question boards are furnished—geographical, historical, statistical, arithmetical, fortune telling, conundrums, and every possible kind of amusing or instructive subject on which questions can be asked. It is regarded as very entertaining and a novelty for educating the young.

The Ball Engine Company, of Erie, Pa., among its recent sales reports the following: John Becker, Fitchburg, Mass., one 35-h. p. simple engine; Thomson-Houston Company, Boston, Mass., one 100-h. p. simple engine; Lewis Benedict, Attica, N. Y., one 50-h. p. simple engine; William Howell, Caldwell, Union City, Tenn., one 80-h. p. simple engine: Newark Electric Light Company, Newark, N. J., one 300-h. p. cross compound engine; Kittanning Electric Light, Heat and Power Company, Kittanning, Pa., one 150-h. p. simple engine; Columbia Electric Light Company, Philadelphia, Pa., one 200-h. p. simple engine; Osage Electric Light Company, Osage, Ia., one 50-h. p. simple engine; Edison Light and Power Company, Minneapolis, Minn., one 300-h. p. cross compound engine; Central District Telephone and Telegraph Company Building, Pittsburgh, Pa., two 50-h. p. simple engines; Industral Improvement Company, Brockton, Mass., one 300-h. p. cross compound engine, one 100-h. p. cross compound engine; Lockport Gas Light Company, Lockport, N. Y., one 100-h. p. simple engine; Electric Improvement Company, San Francisco,

Cal., one 100-h. p. tandem compound engine; S. J. Lefevre, Gibson City, Ia., one 100-h. p. simple engine; Edison General Electric Company, Portland, Ore., three 150-h. p. simple engines.

Messrs. Fraser & Chalmers, of Chicago, Ill., manufacturers of mining machinery and steam engines, have shown their readiness to recognize the merits of electricity as a power transmitter and are about to fit up the foundry and boiler shop and the pattern shop in their Twelfth Street Works with an electric power plant. This plant will consist of two 80-kilowatt generators, one 25-h. p. motor, eight 10-h. p. and eight 5-h. p. motors, distributed throughout the various buildings. The generators and motors will be wound for a pressure of 250 volts. One advantage which is expected to be derived from the use of this potential is that while the electromotive force on the motor circuits will be kept down below any possible danger mark, yet by connecting two dynamos in series a pressure of 500 volts will be obtained, which will permit of testing the various electrical mining machines the motors for which are usually wound for this higher potential. Messrs. Fraser & Chalmers have had this plant under consideration for some months and estimates were submitted by the several companies. The "C & C." Electric Motor Company was awarded the contract. It is understood that part of this plant is to be in running order within 60 days and the entire installation is to be completed within 90 days. The plant will be one of the largest as yet installed for general power purposes, and will afford an excellent demonstration of the advantages of electricity under conditions such as exist in Messrs. Fraser & Chalmers Works.

The Edison General Electric Company is now occupying its new building in Pittsburgh. Referring to the same the Pittsburgh *Despatch* recently had the following: "The building, which is magnificent in every detail, will make their Pittsburgh branch fittingly correspond with the company's importance as well as afford better accommodations for the large volume of business done in this vicinity. The company occupy the entire building and the interior is conveniently arranged and handsomely furnished. The private office of the general manager is on the second floor, where also are the offices of stenographers and assistants. One-half of this floor and the entire floor below is devoted to fixture show rooms. These are spacious and well lighted and are nicely furnished. The packing department and storage rooms are in the basement. The latter probably contain the largest stock of lamps and other supplies between New York and Chicago. Some idea of the immensity of the business done by the Edison General Electric Company can be gained from the fact that during the past year in this section alone they have built no less than 15 street railways, furnished 12 city electric light plants and supplied with lighting plants over 50 mills and factories. They will hereafter be prepared to exhibit at their Wood street show parlors a complete stock of combination gas and electric light fixtures, comprising many special designs suitable for residences, office buildings, churches, etc. In addition to the fixture and supply business, the company will be prepared to furnish general supplies for all plants and systems. The combined features of the business mentioned above made their present spacious quarters a necessity."

Business Notices.

Complete Equipment of electric light and power plants with the Mather system. Also agent for the Perkins incandescent lamp. E. T. Pardee, 14 Butler block, Syracuse, N. Y.

Battery Cut-Out, Cheap.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren street, Syracuse, N. Y.

Until further notice we have withdrawn our agency in Chicago lately controlled by Mr. G. A. Harmount, Monitor Electric Company, No. 149 Wabash avenue. All communications or orders should be addressed directly to Alfred F. Moore, manufacturer of insulated electric wire and cables. Office and works, No. 200 North Third street, Philadelphia, Pa.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS.

U. S. PATENTS ISSUED JAN. 19, 1892.

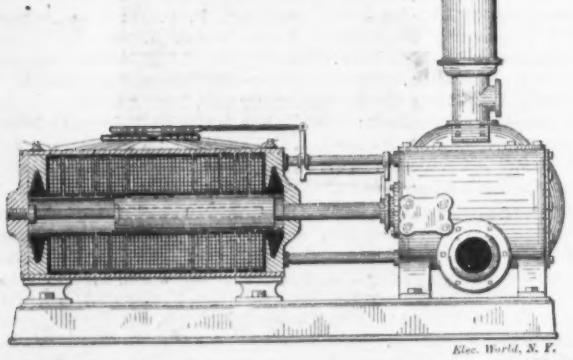
467,153. Automatic Damper Controller; Ferdinand E Chatard, of Baltimore, Md. Application filed May 5, 1891. The combination with a thermostat and an electric motor controlled thereby, a valve operated by the motor and consisting of a fixed cylinder provided with ports and the internal rotary cylinder sustained by a central axis and having ports arranged to register at the top and bottom alternately with the ports of the outer cylinder.

467,160. Holder for Telephone Receivers; Richard Dent of Grand Rapids, Mich. Application filed April 13, 1891. In a telephone, the combination, with the transmitter box and the switch arm, of an arm and a ratchet plate, both secured to the transmitter box, vertically swinging and laterally movable receiver holding lever pivoted between its extremities to the arm and having its inner extremity provided with teeth which engage and disengage the ratchet plate by laterally swinging the lever, and a connection between the switch arm of the transmitter box and the lever.

467,189. Filament for Incandescent Electric Lamp; Philip Hickley, of Evanston, Assignor by mesne assignments to Robert D. Sheppard, of Cook County, Ill. Application filed Aug. 21, 1890. A filament for incandescent electric lamps of the carbonized root of the *Oryza sativa* or rice plant.

467,192. Electric Elevator; Norton P. Otis and Rudolph C. Smith, of Yonkers, N. Y., Assignors by mesne assignments to the National Company, of Chicago, Ill. Application filed July 31, 1891. The combination, with an electromotor and with the controlling device thereof, of means for automatically moving said controlling device from the extreme position in which it is set in throwing the full current into the motor toward a mid-position where less than the full current will be supplied.

467,199. Electric Arc Lamp; Josef Riedel, of New York. Application filed May 23, 1891. In an arc lamp, the combination of a supporting frame having slotted upright guide tubes, upper and lower carbon holders guided by said tubes, cords connected



Elec. World, N. Y.

No. 467,450.—Electro-Magnetic Reciprocating Pumping Engine.

to the ends of the lower carbon holder and in the centre of the upper carbon holder, guide pulleys for said cords, an electromagnet located in the main circuit, and a spring supported armature above the electro-magnet, one of the guide pulleys being attached to said spring supported armature and rising and falling therewith, whereby the arc is produced when the armature is attracted and the lower carbon holder lowered on the switching in of the current.

467,215. Commutator; Henry P. White, of Kalamazoo, Mich. Application filed Feb. 13, 1891. A commutator consisting of a revolvable circular head having on its surface alternating conducting and non-conducting paths on opposite halves and an unbroken conducting path, such alternating paths jogging by each other at their termini.

467,230. Method and Apparatus for Controlling Motors and Generators; Cary T. Hutchinson, of New York, Assignor to the Edison General Electric Company, of same place. Application filed Nov. 11, 1890. The method of regulating or controlling two or more motors or dynamos connected electrically, one or more of the motors or dynamos having extra field magnet coils, which consists in increasing or diminishing the magnetic field of the machine or machines the current in which is too small by passing the current of each of such machines through one of its own extra field-coils and at the same time oppositely affecting said field or fields, that is, diminishing or increasing the same, by passing through another extra coil or other field coils the standard current.

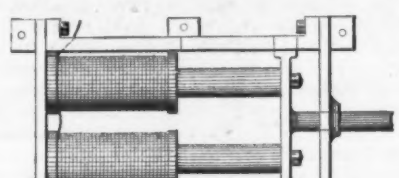
467,233. Process of Electric Metal-Working; Hermann Lemp, of Lynn, Mass., and Walter S. Moody, of Chelsea, Mass., Assignors to the Thomson-Houston Electric Welding Company, of Maine. Application filed April 23, 1891. In an electric metal-working apparatus, the combination, with metal-working clamps or electrodes arranged to pass currents through or into the same portions of the work on lines at an angle to one another, of a continuous current source supplying the one heating current and an alternating current source supplying the other heating current.

467,239. Battery-Zinc; Charles B. Schoenmehl, of Waterbury, Conn. Application filed April 25, 1891. A battery zinc consisting of a hollow zinc stick, a connecting rod screw-threaded into said stick, a glass tube surrounding said rod and forming a continuation of the zinc stick, and means for holding the parts in assembled position.

467,240. Electric Battery; Charles B. Schoenmehl, of Waterbury, Conn. Application filed April 25, 1891. In a battery, the combination, with a top provided with holes and constructed of non-conducting material, of the carbon rods, a drawn sheet-metal cap or shell fitted and secured upon the top of each rod, and a connection above the battery top whereby the rods are secured together mechanically and electrical connection established between them.

467,243. Electromagnetic Brake; Henry Edmond Walter, of London, England. Application filed April 3, 1891. An electromagnetic brake for railways, composed of electromagnets carried by the vehicles, with the magnet poles in close proximity to a fixed longitudinal conducting bar, plate or rail, but retained by spring stops on the vehicle from coming into contact with them, and a dynamo for supplying the coils of such magnet or magnets with electrical current when the speed at which the vehicle is traveling has to be diminished.

467,250. Trolley for Electric Railways; Edwin R. Harding, of Winthrop, Mass. Application filed Jan. 3, 1891. The combination, with a pivoted trolley and an impelling spring therefor, of an arm affixed to the trolley base, a lever pivoted to said lever and engaged with the outer end of the trolley spring, said lever and spring support being arranged so that when the lever is in its normal position it holds the spring support in position to main-



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No. 467,259.—Electric Railway Brake.

tain the spring in a state of operative tension, and a connection between said lever and the trolley arm, whereby when the trolley arm rises above its normal position said lever and spring support are displaced.

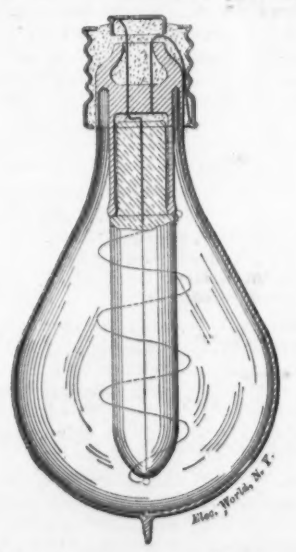
467,255. Liquid Rheostat; Hermann Lemp, of Lynn, Mass., Assignor to the Schuyler Electric Company, of Middletown, Conn. Application filed March 22, 1889. The combination, with a tube of insulating material containing a liquid resistance and communicating at its lower end with an exterior body of liquid, of a circulating tube connected at one end to the first tube at a level below the level of the liquid therein and at its lower end with said exterior liquid body at a lower level.

467,259. Electric Railway Brake; Edmund Verstraete, of St. Louis, Mo., Assignor of one-half to Peter M. Kling, of same place. Application filed Aug. 8, 1890. The invention consists of a railway car provided with the usual brake beams, levers, etc.; a rectangular frame carries a pair of electromagnets, each having a car attached to a sliding crosshead; lever connection is made between the crosshead and brake beams. (See illustration.)

467,270. Incandescent Electric Lamp; Charles H. Wilkins, of Chicago, Ill. Application filed June 19, 1890. The combination, with the bulb and filament of an incandescent lamp, said bulb being provided with an interior glass socket integral with the bulb and opening into the interior of the latter, of a reflecting body or core of lime or other refractory non-transparent white substance, said body or core being sustained in position within the bulb by having one of its ends inserted and secured in the socket. (See illustration.)

467,276. Incandescent Electric Lamp; John L. Curtiss, of Grand Rapids, Mich. Application filed July 24, 1891. An electric motor provided with a socket at one end adapted to receive an incandescent lamp and electrodes, at the other adapted to fit the lamp socket, and electrical conductors from the electrodes to the lamp.

467,287. Automatic Cut-out for Gas Burners; James E. Hogan, of Oakland, Cal. Application filed April 20, 1891. A safety attachment for gas burners consisting of a supplemental cock or valve, whereby the supply of gas may be cut off from a burner, a means whereby the cock may be turned so as to allow the flow of gas through it to the burner, an expansible conducting material supported above the burner tip, a battery having wires, one of which is connected directly with the expansible conductor, and the other is insulated and supported in such position that the circuit is completed by the expansion of the conductor, an electromagnet connected with the same circuit, a lever carrying an arma-



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No. 467,270.—Incandescent Electric Lamp.

ture, which is acted upon by said electro-magnet when the circuit through the magnet is completed, and lugs or attachments connected with the supplemental cock or valve whereby the latter is turned to cut off the flow of gas, when the electrical current is caused to pass through the magnet by the cooling of the expansible conductor, and a cutting off of the short circuit thereby.

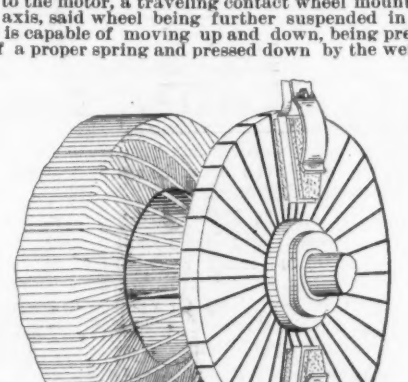
467,318. Commutator for Dynamo-Electric Machines and Motors; Elihu Thomson, of Swampscott, Mass. Application filed Jan. 31, 1891. The combination of a disc commutator composed of sector-shaped insulated sections fitted and secured together, with brushes bearing on opposites sides of the disc, and oppositely acting springs connected directly or indirectly with both brushes and thereby equalizing the pressure of the said brushes against the sides of the disc. (See illustration.)

467,338. Rheostat; Charles Williams, of Baltimore, Md. Application filed Sept. 30, 1891. In a rheostat, the combination, with a non conducting surface coated with a resistance material, of a series of conductors between which the resistance material forms a path for the current, a movable contact-piece adapted to complete the circuit by forming contact with any one of the series of conductors, and a series of collecting sectors embedded in the resistance material and connected with the conductors and each extending the width of the path of resistance material at the plane of the sector.

467,358. Regulator for Electric Generators; Edwin Wilbur Rice, Jr., of Lynn, Mass., Assignor to the Thomson-Houston Electric Company, of Connecticut. Application filed May 2, 1890. The combination, with a dynamo-electric machine, of a derived circuit field magnet, a resistance in series with said field magnet, and a short circuiting device for said resistance controlled by an electric magnet set to respond only at the point of maximum output, whereby when the said point of maximum output has been reached the magnet acts to cut in the resistance and thereby decrease the field magnet strength and the electromotive force of the generator.

467,372. Galvanic Battery; Fernand Gendron, of Bordeaux, France. Application filed May 14, 1891. An electric battery comprising a series of cells containing exciting and depolarizing liquids in combination with an electric motor actuated by a portion of the battery elements, pumps driven by the motor and arranged to produce a circulation of liquids through the cells, a sliding rod carrying contact keys to regulate the number of elements in use, and magnets arranged in a shunt circuit and adapted to move the rod into position to be moved by the motor.

467,448. Electric Railway; Charles J. Van Depoele, of Chicago, Ill. Application filed June 22, 1885. In an electric railway system having overhead conductors from which the current is taken to the motor, a traveling contact wheel mounted flexibly upon its axis, said wheel being further suspended in a frame in which it is capable of moving up and down, being pressed up by means of a proper spring and pressed down by the weight of the



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suspended conductor, and following the undulations with an elastic contact.

467,449. Controlling Apparatus for Electric Motors; Charles J. Van Depoele, of Lynn, Mass. Application filed March 19, 1891. A hydraulic controlling apparatus for electric motors, comprising a plurality of cylinders connected in continuous series by pipes extending from the front end of one cylinder to the rear end of the next and filled with liquid, a piston for each cyclinder normally located at the centre thereof and provided with an outwardly extending piston rod, mechanism for imparting motion to one or other of the pistons, thereby displacing the liquid and actuating all the pistons simultaneously, and mechanical connections between the pistons of the actuated cylinders and work to be performed.

467,450. Electro-Magnetic Reciprocating Pumping Engine; Charles J. Van Depoele, of Lynn, Mass. Application filed March 19, 1891. An electromagnetic reciprocating pumping engine comprising a plurality of sets of motor coils, a magnetic plunger adapted to be reciprocated therethrough, a coil for magnetizing said plunger, and means carried by the plunger for alternately shifting the current from one set of end or motor coils to the other. (See illustration.)

467,451. Reciprocating Electric Engine; Charles J. Van Depoele, of Lynn, Mass. Application filed July 10, 1891. A reciprocating electric engine comprising a motor coil or coils in circuit with the terminals of a source of continuous current, in combination with a coil or coils connected alternately in derivation from the continuous current coils, and means for supplying the shunt coil or coils with currents having a defined rise and fall and of alternating character, and a magnetic plunger adapted to be reciprocating within said coils under their combined influence.

467,465. Electric Lock; Frederick S. Holmes, of Boston, Mass., Assignor to James W. Torrey, of Philadelphia, Pa. Application filed Feb. 3, 1891. The combination, with an electrically actuated combination lock arranged within a safe or other receptacle and comprising a series of tumblers, a ratchet wheel to operate them, and an electro-magnet located in said safe to rotate said ratchet wheel, of a switch located outside of the safe and connected in circuit with said electro-magnet, an electric generator connected to said magnet through said switch, a circuit breaker to control the operation of the magnet, and an electric motor to produce movement of the circuit breaker.

467,478. Electric Railway Signal; William F. Z. Desant, of New York. Application filed Sept. 26, 1890. In a block signal system, a series of electrically divided blocks, a series of semaphores or visual signals, electrical conductors joining the blocks, and electromagnetic means for controlling local circuits, one at each signal, with batteries and electrical motors in said local circuits, the motors being geared to the signals, circuit connections being had through the adjoining ends of one pair of rails and the car wheels as they pass successively over said ends, whereby the signals are continuously vibrated or moved as the train enters each block.

Copies of the specifications and drawings complete of any patent mentioned in this record—or of any other patent issued since 1886—can be had for 25 cents. Give date and number of patent desired and address The W. J. Johnston Co., Ltd., Times Building, N. Y.